WATER and FOUNTAINS in URBAN SPACES

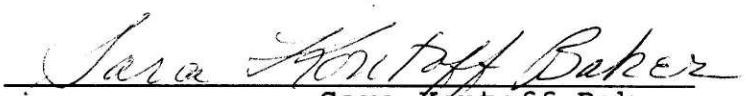
by

Sara Kontoff Baker

Bachelor of Arts
Boston University
Boston, Massachusetts
1954

SUBMITTED TO THE DEPARTMENT OF ARCHITECTURE
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS OF THE
DEGREE
MASTER OF SCIENCE IN VISUAL STUDIES AT THE
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

FEBRUARY, 1986

Signature of Author 
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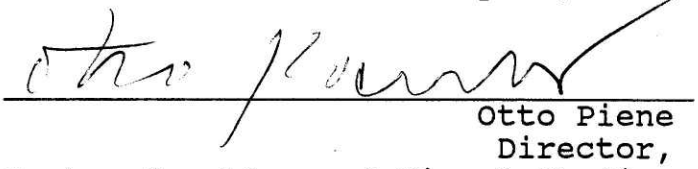
Certified by 
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Submitted to the Department of Architecture
on January 17, 1986
in partial fulfillment of the requirements for the Degree of
Master of Science in Visual Studies

ABSTRACT

The main idea of this thesis is that contemporary fountains in urban spaces should relate to contemporary culture, congruent with current technological developments and shaped by new physical and psycho-social needs, just as fountain forms of the past were influenced by earlier physical and cultural determinants.

Today science and technology are major influences in our culture affecting urban life on many levels, altering our world view, urban form and social interactions. New knowledge from space exploration, for example, has shifted our view toward a greater understanding of ecosystem and process, while cities have become more geared to machines in scale and pace leaving fewer green spaces. Studies indicate that computer workplaces tend to produce more fatigue, stress and in extreme situations, sensory deprivation in human beings. Therefore, these fountain projects are attempts to create humanizing environments which connect people to nature with the understanding that human beings are part of the ecological system, affecting and being affected by their environments.

Water is associated with nature bringing visual qualities and associated meaning; archetypal and personal. It can appeal to all senses with an apparent capacity to restore them and its sense of vitality and life might help create a better balance between nature and our technological world.

Thus, WATER WALLS was created. It is an interactive, environmental fountain designed specifically for urban spaces with significant new needs; neighborhoods and recreation areas of computer workplaces. WATER WALLS is a 6'8" corner fountain (representing a room) with plexiglas walls and floor, through which water flows. People may enter the fountain and be surrounded with flowing water, experiencing its sight and sound within this semi-enclosed environment. Lighting is sound-sensitive, responsive to noise or voice. This fountain creates a new environment within an existing environment, bringing water (nature) into depersonalized spaces in an

effort to transform them into more humanized places.

The first part of this thesis describes historic and contemporary fountains and some factors (i.e. irrigation needs, symbols, socio-political forces), which have affected their form and use. The second part describes WATER WALLS; its evolution and construction, as well as descriptions of other proposals for water gates, water arches, water gardens and a holographic fountain.

Thesis Supervisor: Otto Piene
Title: Director, Center for Advanced Visual Studies

ACKNOWLEDGEMENTS

Special thanks to my advisor, Otto Piene, to Charles Miller and Thomas Bligh for their technical assistance and to Pere Viader i Guixa and Servei il.luminacions Artistiques, Barcelona, Spain for their technical information and tour of the Montjuich fountain.

Special thanks to Gyorgy Kepes whose writings were a source of inspiration.

Thanks to my husband, Elliot for his support, criticism and humor.

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INTRODUCTION

This thesis, presented in two major parts, will explore the art and function of water environments and fountains in urban spaces. The first part is historic, tracing the evolution of some specific forms as shaped by physical and cultural determinants. The second part presents a rationale, my fountain proposals and documentation of the process of constructing WATER WALLS, a life-size functional fountain, a model, representing an environment of water walls and water floor.

Basic patterns of early irrigation systems evolved into art forms changing with societies' changing needs and attitudes. Just as urban fountain art of the past evolved from existing cultures, contemporary fountain art should emerge from contemporary culture, congruent with current technological development, new attitudes and psycho-social needs.

Thus, I have developed WATER WALLS, a public fountain environment which invites the viewer to enter the sculpture surrounding him/herself with flowing water. I have chosen to work with water because of its visual qualities, and deep connection to human beings on physical, (as both source and sustenance of life) and symbolic levels.

Images of water hold a place deep within the psyche of human beings, and are expressed symbolically through archetypal images in art, mythology, religion and ritual, acknowledging water's life-giving and life-sustaining qualities.

Nearly every myth of creation relates to water as the source of life, in fact, one of the earliest personifications of natural phenomena was the deification of the Babylonian water god, Ea. (Moynihan, 1979) Particular rituals related to birth, death and purification are also associated with water often finding expression in distinct architectural forms such as ablution tanks in mosques and baptismal fountains in churches.

Topography, climate and unequal distribution of fresh water on the earth's surface led to diverse methods of water retrieval, storage and distribution. These water carrying forms related to irrigation, but were influenced by available technology, material, psycho-social and visual considerations. Irrigation forms ranged from designs as varied as the terraced hillsides of China, to the rectilinear pools and canals of Persia, to the aqueducts of Rome, all influencing later fountain design.

For example, the concept of the Persian pleasure garden, with its appeal to all senses, spread to Spain (influencing contemporary Spanish and Portuguese design) and to India with the Mughals. The necessity for building fountains at terminal points of Roman aqueducts, led to the proliferation of city fountains during the Roman period. Restoration of the aqueducts by the Popes in the Middle Ages, brought abundant water, inspiration for Renaissance and Baroque fountains. Renaissance models influenced fountains at Versailles, as well as

elsewhere in Europe and the United States.

Essential philosophical concepts were often revealed in fountain design. Oriental water enviroments and those derived from Persian concepts created enclosed spaces inviting reflection and introspection, expressing a sense of human beings' unity with nature, while those derived from Roman and later Italian design exhibited a sense of play and celebration of human mastery over nature. The latter was spectacularly displayed after developing technology produced powerful jets enabling the presentation of elaborate water theatre at Versailles, Frascati and Tivoli. There, ingenious hydraulic devices were used to create water games and "jokes" as well as monumental displays of fireworks and fountains.

Apart from previously mentioned uses, water played a direct role in the socio-political aspects of life. According to Karl Wittfogel, (1957) the need for water management in a hydraulic society permitted the organization of a bureaucratic framework, headed by a central authority which allowed for easy socio-political control, often resulting in despotic forms of government.

Today, water management is also a critical issue which will affect the future form and social organization of cities. Limited water resources and larger populations will demand new approaches to water management leading perhaps to more experimentation with fountains and recreational water environments designed around water management systems (Kepes, 1972). As

one views urban centers in the western world, one perceives evidence of the physical, social and psychological impact of an increasingly technological society. Cities have become more complex, more geared to the machine than to the human being in scale, pace and rhythm, often resulting in visual monotony and human isolation. Fewer green spaces remain within the central core, diminishing opportunities to relate to nature within the urban environment. Higher population density and increased construction have prevented adequate restoration of urban aquifers, reducing water resources.

Many contemporary artists, influenced by science and technology, perceive the world in more global terms, integrating art and technology and addressing ecological issues. Their work may be categorized in the following ways: environmental artists utilizing the environment to modify and change their work, for example, changing water to other states, such as steam, fog or ice, focusing on process; those creating spectacles and water theater often integrating new technology (lasers, computers); those actually re-creating nature in the urban environment and those focused on urban ecology.

I believe that water should be reintroduced to urban areas to serve a multitude of functions; visual, recreational and social; creating more human environments within current environments. Since water appeals to all senses, and has symbolic associations, water environments can provide direct,

immediate, sensory input helping to restore a balance between the world of nature and the world of high technology.

My thesis describes concepts for public fountains, expressed also in model form, comprising a fountain environment for a central urban area, consisting of water gates, water walls and floors, water arches, water gardens, and a holographic fountain. Individual fountains within this group are directed toward two other sites -- neighborhoods, and recreation areas of the computer workplace. My major project, WATER WALLS, is a constructed 6' 8" working fountain, a model for a larger semi-enclosed environmental outdoor fountain, or a room-sized space indoors. This particular fountain represents a complete room, consisting of clear plexiglas walls and floors through which water flows. In this model, I have utilized transparent contemporary material (e.g. plexiglas) so water flow is apparent. The lighting is sound-sensitive, (responsive to noise or voice) and the viewer may participate by entering the model, surrounding him/herself with flowing water, viewing it and hearing it splash, without getting wet.

I have considered the computer workplace as an appropriate site because recent research indicates negative human responses to the computer workplace. For example a Swedish study (Frankenhaueser, 1972) noted that some people working with computers tend to exhibit symptoms of sensory deprivation similar to those experienced by astronauts participating in

sensory deprivation experiments. Because water appeals to all senses, fountains and water environments within recreational settings in computer workplaces could provide immediate sensory input, thereby helping to counteract negative effects. As future cities become more technological, more need will exist for restorative places and experiences. Fountain and water environments might help create such oases.

Other well frequented but often overlooked sites for fountains are underdeveloped urban neighborhoods inhabited by the elderly, families and children, whose mobility is often limited. (Alexander, 1967) Fountains in small neighborhood parks can be visual, recreational, educational (Lady Allen of Hurtwood, 1984) and social, creating specific places where spontaneous, natural, interactions can take place. The water experience may be ecological as well, providing water for local gardens as well as replenishing the urban aquifer.

Fountains and water environments may have broader application if designed to consider ecological issues facing contemporary urban society. Gyorgy Kepes (1972) suggests that "water-purification plants, located in central areas of cities[1], . . . can serve in the best contemporary and vital sense as public monuments directed toward the future and not the past," and the more our environment is polluted and our access to pure sources more limited, "the more important it is

[1]Gyorgy Kepes
The Artist's Role in Environmental Self Regulation
Arts of the Environment, Ed. Gyorgy Kepes, George Braziller, N.Y., 1971, pg.171.

to re-experience its richness within the urban scene."[1]

Charles Moore speaks of creating harmonious design and states that designs "composed in time and space . . . create a sort of resonance with a sympathetic nature . . ."[2] and that moving water "suggests an awareness of movement that connects our lives to the processes of life, and a sense of the water cycle." (Moore, 1957).

[1]Gyorgy Kepes
The Artist's Role in Environmental Self Regulation
Arts of the Environment, Ed. Gyorgy Kepes, George Braziller, N.Y., 1971, pg.171.
[2]Charles Moore, WATER AND ARCHITECTURE, University Microfilms International, Ann Arbor, Michigan, USA, London, England, 1957, pg.164.

PHYSICAL ASPECTS OF WATER

The essential relationship between water and living things is well known - it is both life giving and life sustaining -- essential for life on earth. Human beings evolved from water and play with water. If affects our climate, food supply, recreation, social and political organization.

All of the earth's waters are essentially the same, since all waters move through the hydrologic cycle, however, this idea was not generally accepted until Vitruvius' and Pallisay's water measurements in the 1500's followed by Pierre Perrault's and Edmund Halley's experiments which measured precipitation and discharge in the Seine. Although Leonardo da Vinci also promulgated a theory regarding the hydrologic cycle, fresh water was generally thought to be derived from rain only. Unesco defines hydrology as follows: "Hydrology is a science that treats of water of the earth, their occurrence, circulation and distribution, their chemical, physical, properties, their reaction with their environment including the relationship to living things. The domain of hydrology embraces the full life history of water in the earth's picture of cycles." (Laconte, Haimes, 1978).

Hydrology also "embraces the full life history" of human beings who drink it, bathe in it, worship and play in it. A growing awareness of the hydrologic cycle points up the interrelatedness of human beings and all elements within an

ecological system. Many artists, historical and contemporary, from Bernini to Yves Klein have found inspiration in these ecological concepts.

During its continuous circulation through the hydraulic cycle, water often causes wide variations of climate. Random precipitation results in imbalanced water distribution causing floods or drought affecting agriculture and society. Human need for water is constant, enormous and critical, since 65% of the human body is composed of water and a loss of 12% is fatal (Blake, 1956). In a sense, the human body is an ecological system.

Although plentiful, covering approximately 70% of the earth's surface, most of this water is salty (55 parts salt by 1,000 parts of water) so the earth's fresh water supply comes directly from the hydrologic cycle. However, unequal distribution over land has created arid or semi-arid conditions in 3/4 of these areas, causing major human effort to be directed toward the retrieval, storage and distribution of fresh water. (Odum, 1959) Variations in rainfall throughout the world is suggested by the following comments. Egypt's annual rainfall is so limited that for centuries it depended upon its stored water captured by annual Nile overflow, heavy monsoon rains may or many not arrive when needed in India, causing flooding or drought, and because practically no rain falls at all in the Kalihari desert, bushmen extract droplets of water from tubers. Reduced rainfall creates loss of

biomass" or vegetation (which prevents the topsoil from drying out) so the population is less likely to be supported by either agriculture or the water supply. Human beings have intervened in an effort to control and preserve the water supply, although they are unable to control the hydrologic cycle. (Lenihan, Fletcher 1976).

In its natural course through the hydrological cycle water evaporates, condenses, falls to earth, and is reabsorbed into the earth restoring the aquifer. However, human systems have interfered with these natural processes. For example, high density urbanization has increased land area covered by non-permeable surfaces, curtailing the amount of water returning to the aquifer, resulting in a lowered water table.

Water is transparent, its form variable - determined by its container's shape. Its qualities of movement permit seepage into the ground as well as projection into space and high surface tension permits water under pressure to reach great heights, for example, 300 feet in the Lake Geneva fountain. Water falls, flows, cascades and reflects jets; its activities and qualities determined by pressure, velocity, volume and edge conditions.

Falling water may assume the form of a smooth sheet when falling over a jutting ledge if an opening is notched beneath the edge so water will not dissipate and run horizontally. If the edge is smooth and round (as the I.M.Pei reflecting pool at Boston's Christian Science Center), water assumes a smooth

form. If the edge is irregularly patterned, (as in the fountain in Madrid) water breaks up into varied rivulets and droplets catching more light, appearing white and sparkly. Vessel width or shape affect form of flow and can purify water, creating bubbling whirls if enclosed in a serpentine or figure eight forms, becoming more turbulent as width narrows. (Wilkes, 1973). Although usually clear, aerating jets force air into streams producing cascading water that appears bubbly and white. Water can also act as a mirror, (as in the Court of the Myrtles at the Alhambra) reflecting the environment, or act as a lens or prism (as in Centerbeam).[1]

Natural fountains, such as Niagara and Victoria Falls, the geyser, Old Faithful, volcanic fields of Iceland and the Flegrean Fields of Italy, as well as steaming jets emitting from Mounts Etna and Vesuvious, for example, present compelling images of water's power on a monumental scale. These falling and jetting fountains of nature serve as inspiration for artists who have attempted to emulate the power of nature in controlled environments. Buigas (1978)[2] comments that his intention in creating his monumental computerized fountain in Barcelona is an attempt to demonstrate the power of nature and the water cycle.

[1]Water Prism multi-media environmental art - Center for Advanced Visual Studies. See chapter on Contemporary Artists.
[2]Carlos Buigas, artist and designer.

SYMBOL

Water has an archetypal basis in all cultures, expressed as a primary symbol through images in art, religion and myth, particularly myths of creation and purification. In this section I will describe some roots found in myth and religion, denoting water as the source of life and means of purification, illustrating how some concepts shaped by individual culture found expression in fountains.

The following myths all relate to water as a source of life. Deification of the Assyro-Babylonian water-god, Ea, considered to be the creator of all things, was one of the earliest personifications of natural phenomena (Kuch, 1968). In Peruvian legend a llama states that the sea killed everyone except one person from whom all other came (Moynihan, 1979). The Greek Oceanus was the elemental force giving birth to all water gods, Neptune and Tritons, and Persian myth focused on the Four Rivers of Life from which all life evolved. This basic theme of water as the source of life is expressed in the Old Testament and The Koran which present the image of 4 rivers parting as related to the source of life.

Images of water as purification also abound in early myths and rites. Joseph Campbell (1964)[1] reports that myths relating tales of "exposure on the water, and rescue by an

[1]Joseph Campbell, The Masks of God, Occidental Mythology, The Viking Press, 1962, pg.73.

irrigator," are found in Judeo-Christian and Roman myths. These images, as well as those where water suddenly appears, all represent purification rites. In Hebrew tradition, ritual baths were required of women before marriage and ritual hand-washing was required after a funeral. Muslim tradition also required ritual hand-washing and ablution tanks are distinct architectural forms in mosques. These pools had to be filled to the brim constantly, necessitating the construction of surrounding channels for the overflowing water.

In nearly all religions, water is viewed as the source of life and means of purification. Taoism suggests that the rivers of life are arteries of the world providing the life blood, not unlike the Islamic or Judeo-Christian concept that the four rivers provide the source of life.

Purification rites in all religions relate to water, from Hindu practices of bathing in the Ganges to the use of ablution tanks in Mosques and Baptismal fountains in churches. All these rites symbolically wash away impurities. Rivers also played an important role in ancient Egyptian purification and fertility rites, when a granite sculpture of the god, Amon, was floated down the river from its home in the Temple of Karnak to mate in Thebes (Luxor). A week later it was returned overland to its place in the Temple, where a pool for purification rites stood in inner sanctuary.

Early attitudes, myths and rituals regarding water

affected fountain design.

One example, specifically related to myth is visible in the Alhambra where The Patio of Lions, (fig. 1) divided by four water channels, symbolized the four rivers of life. That central space, bounded by intersecting channels where the fountain of twelve lions stands, (fig. 2) was considered a holy place; the place where God and man met (Crowe, 1972). Since the Koran prohibited still water, an essential element in Mughal fountains was flowing water representing life itself. In the Alhambra small low bubbling fountains abound and although many are round, others take many other geometric forms. Apparently the water container's shape also had symbolic relevance. Crowe (1972) relates that octagonal basins were considered a "symbol of reconciliation of the material side of man (square) with the circle of eternity." The combination of geometric forms with natural growing plants also had significance symbolizing the unification of order and freedom.

Actually Mughal gardens derived from the Persian pleasure garden, which symbolized harmony and unity of human beings and nature, synthesizing spiritual and practical elements, integrating religion and irrigation all in an enclosed space. These environments appealed to all senses with sound, color and scent important (Moynihan, 1979, Jellicoe, 1975).

Contrasted with Persian integrated enclosed environments

are Renaissance and Baroque fountains of Italy where Bernini's Fountain of the Four Rivers, (fig. 4) for example, derived essentially from the same myth, (water from the four rivers as a source of life) presented vastly different expression and interpretation. This fountain commemorated water as source and sustenance of life through monumental sculptures and abundant water offering an image of power, energy and movement. Here the emphasis was on art; sculptural forms representing classical myths and allegories (fig. 3, 4). This was a major shift in fountain design where sculpture and human representations became major elements (Kuck, 1968). Water flowed from and over bodies, distinctly opposite Muslim tradition which forbade human representation.

Although no human forms were presented in Mughal fountains, the earth mother and goddesses of fertility were prevelant images in early mythology, even as early as 2125 BC, when a west Asian stone fountain was believed to have been created in Mari. Water, pumped through a hole in the base, flowed out through the vase representing flowing waters of the world as the source of life (Moynihan, 1979). Fountains incorporating sculptures with water flowing from or through the body are related to fertility myths and are expressed in ancient, Renaissance and contemporary works. Water flowing through female sculpture's breasts into a balustrade at the Villa d'Este, Tivoli, and water gods of Bernini's fountains

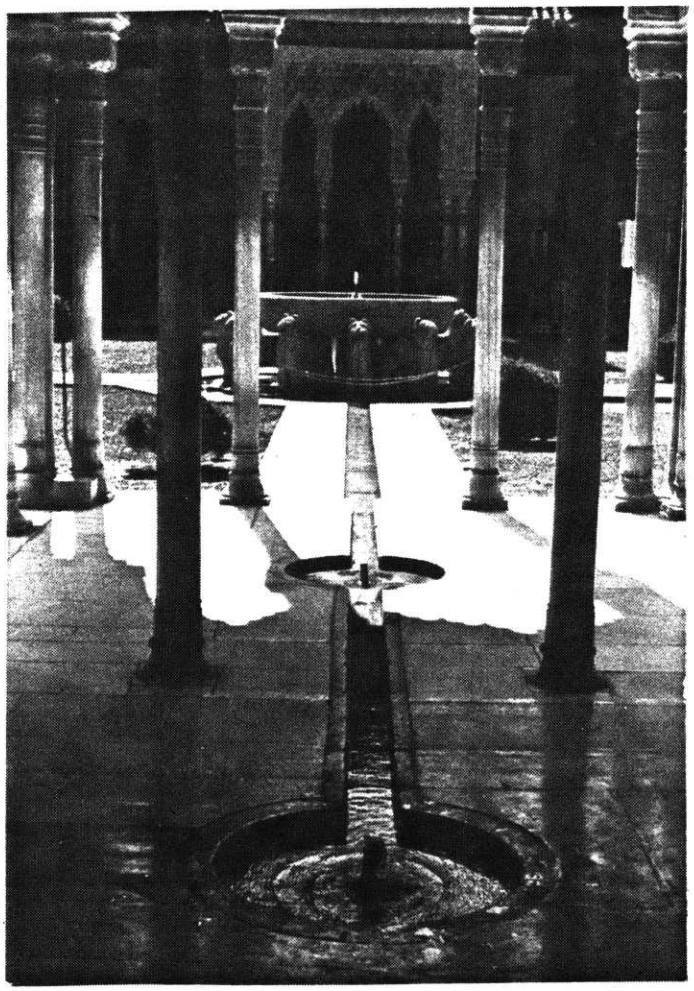


Figure 1

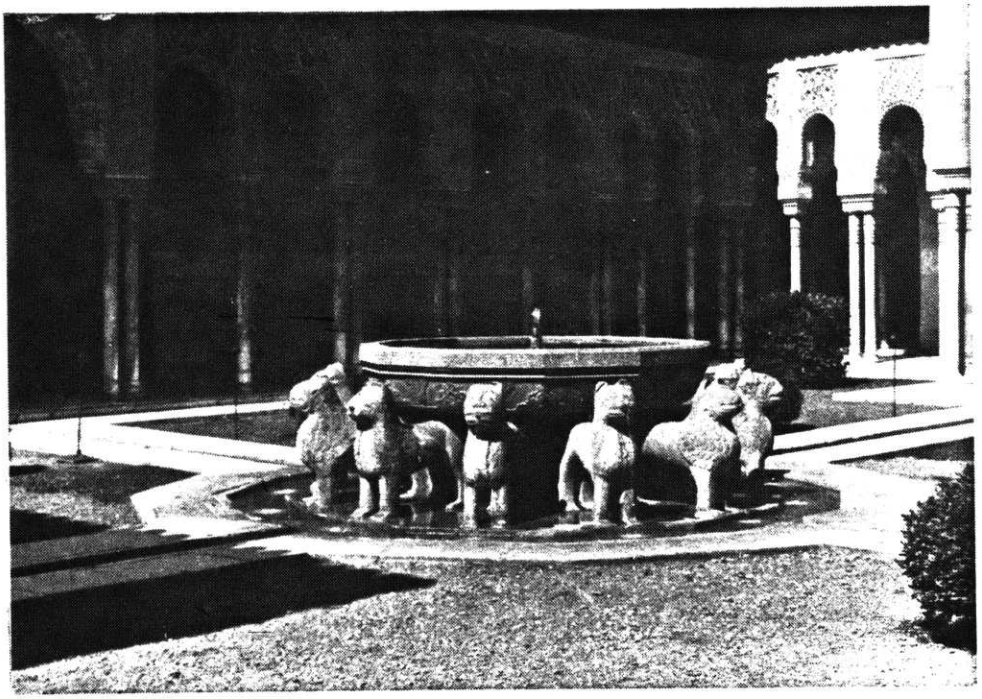


Figure 2

and Milles' Contemporary Fountains in St. Louis all express this idea. Representations of the cosmology of Greek and Roman gods became important if not primary sculptural images in Bernini (1598-1680) (fig. 3, 5) and Borromini (1599-1667) (fig. 4) fountains in Rome, where allegorical sculptures of Neptune and Tritons symbolized water as the source and sustaining force of life. Kuch (1968) believed that the reassuring streams of water flowing from and over bodies symbolized fertility, water's continuity and the source of good health, while the fountain itself represented the place of the water gods, reminding people of their debt to them. Trevi Fountain[1] (fig. 3) also represents the power of water. Salvi[2] wrote a symbolic analysis commenting that the river god sculpture represented ocean in an angry mood, while the companion sculpture suggested calm, as it led a placid steed through the ocean (Morton, 1966). The visual effect of volumes of rushing water over powerful sculptural forms represent both the power of water as well as the power of humans over nature and the predominance of art over nature, a new theme.

This fountain also produces a volume of sound heard from blocks away like the ocean reminding one of Moore's comment that "water works best when it suggests that it comes from or goes to a great and even infinite distance, but that it is

[1]Derived from an earlier design by Bernini.
[2]Artist who designed its present form.

Figure 3

Figure 4

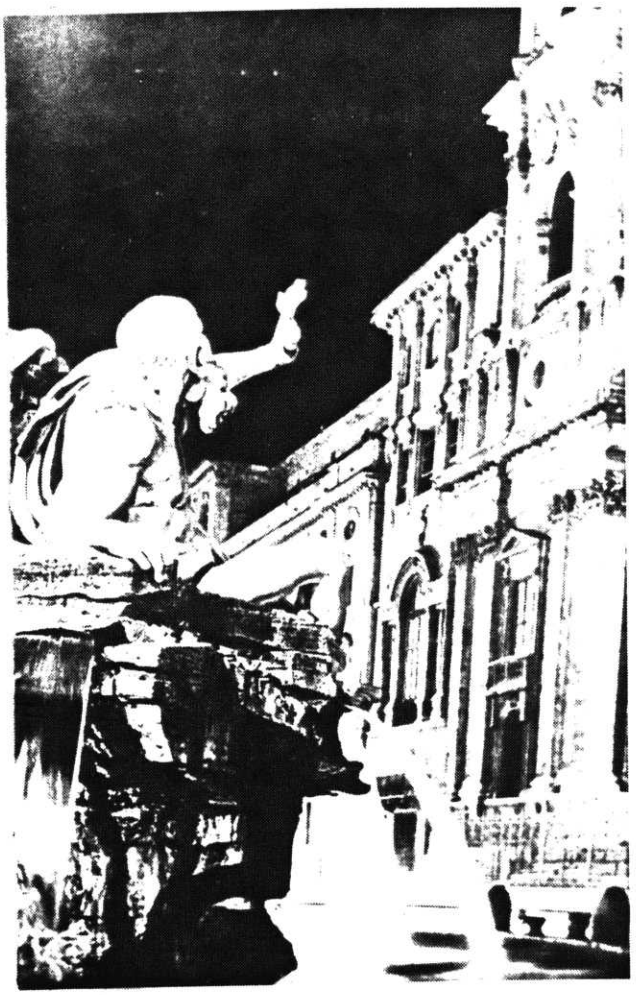


Figure 5

very close to use while it is here."[1] our lives and life's processes (Moore, 1957).

Water suggested the continuity of life and relationship for the Chinese also. Clifford (1963) speaks of Lao-Tsu, who recommended that one should drift on life-floating. This is expressed in a typical Chinese garden plan consisting of canals surrounding a pavilion, where one could sit and contemplate separated from the rest of life by water. Essentially the enclosed Chinese garden provided a poetic setting for contemplation stressing symbolism, proportion and the union of opposites (ying-yang). Often miniaturized nature symbolized streams, cascades, mountains, rocks, pebbles, and artificial lakes bridged by half-circles (often of precious material, such as jade) which formed completed circles with its reflection.

Abstract and highly symbolic Japanese gardens followed strict laws regarding water forms. Water had to flow, East to West to work away impurities. However, dry gardens where water was represented by sand only presented the most unique and symbolic form. These gardens were primarily places for contemplation and introspection (Jellicoe, 1975).

Perhaps the most abstract and suggestive gardens is the Ryoan-yi (1499) garden in Kyoto where quartz sand is raked

[1]Charles Moore, WATER AND ARCHITECTURE, University Microfilms International, Ann Arbor, Michigan, USA, London, England.

into wave-like forms. Rocks, representing mountains, suggest obstacles for the waters of life as they flow into the sea of nothingness. Raked sand and mounds of sand in the Daisen-in garden leave interpretation to the individual viewer (Jellicoe, 1966). (fig. 6, 7) Here assymetrical arrangements allow different views from different places, offering the viewer multiple perspectives. This basic philosophical idea differs from Baroque and Renaissance concepts, where designs are viewed from a fixed perspectives.

In the ancient Western world natural springs were deified becoming shrines for religious water rituals, sometimes protected by elaborate structures as in Corinth and Delphi. In Corinth, a stream running beneath a rock became the "place" of the water god, Priene, over which a temple was built in 560-510 BC to preserve the spring's purity. Other shrines were found in simple natural groves, but one of the most elaborate was dedicated to Aesculapius, the god of health. There in Epidaurus, Greece, a kind of holistic therapy was practiced in an elaborate spa with several buildings dedicated to medical care and surgery. It was believed that patients who drank from the sacred fountain would fall into a "temple sleep" and be cured. In appreciation, they tossed gold coins into the fountain.

Water is also a symbol in Christianity, expressed in purification rites of baptism, signifying purification and re-birth through immersion in water. The need for special places

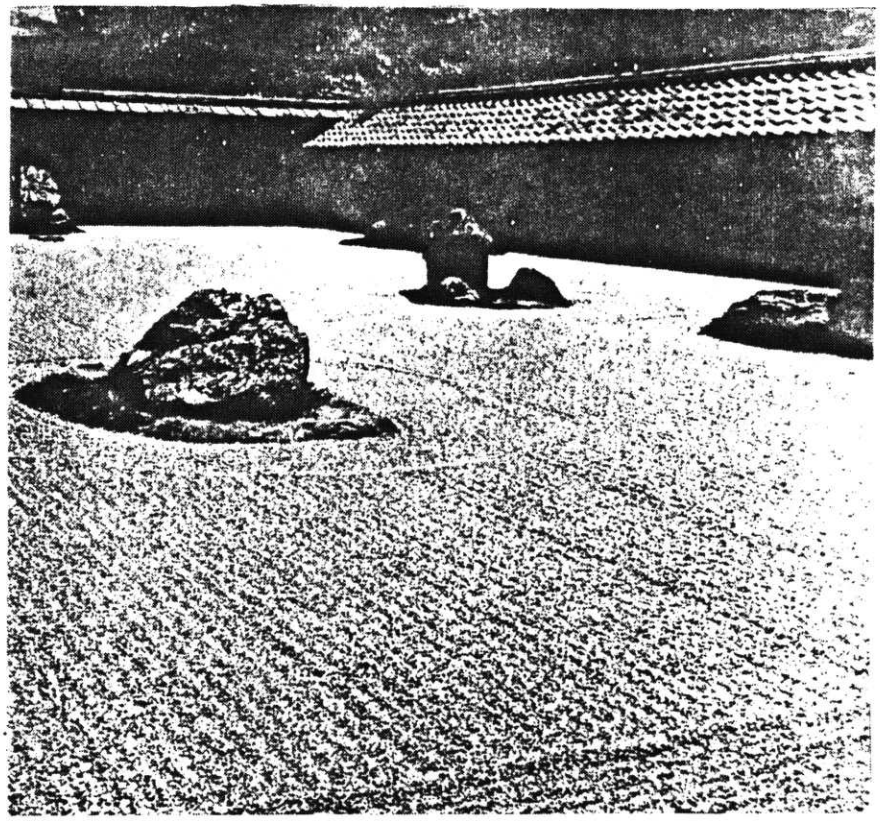


Figure 6

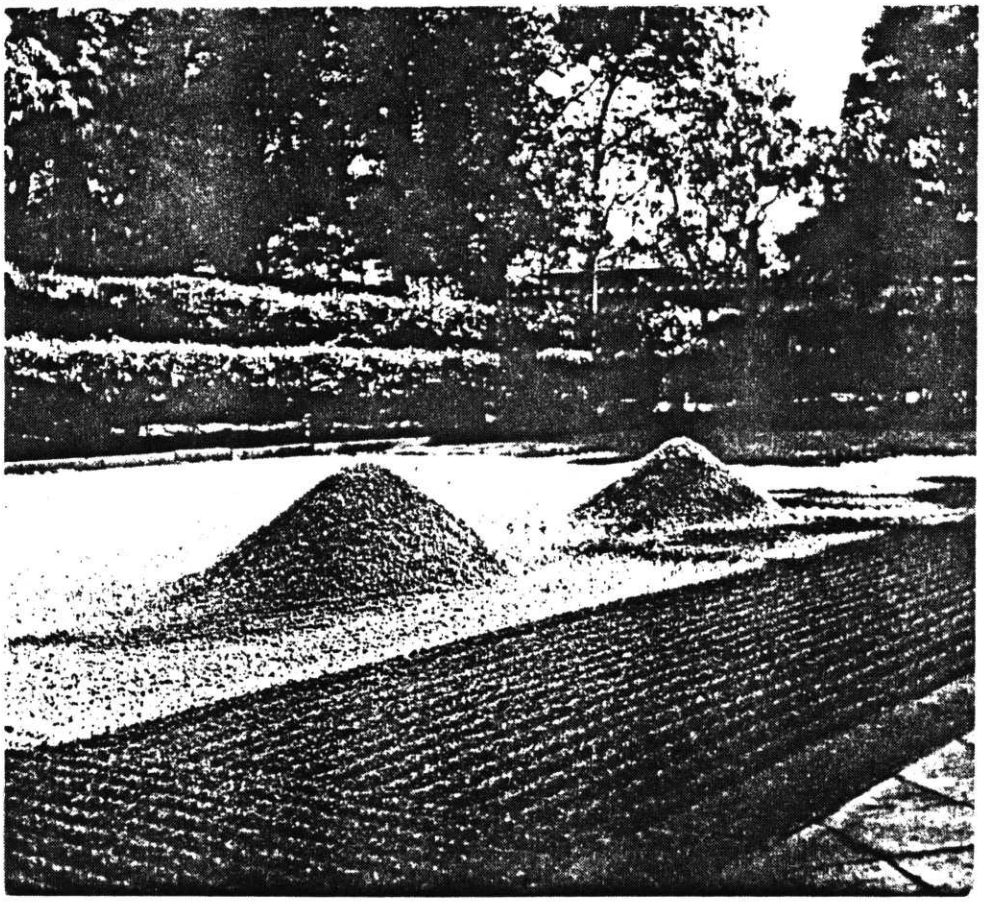


Figure 7

to hold rites led to the construction of separate buildings situated beside churches, designed with large interior pools for these purposes. They were often octagonal or round (as were the pools) often large, made of marble and richly decorated. Among the largest and most beautiful are those at Pisa, Florence and Rome, where the Baptistery at the Lateran Church is considered to be one of the oldest. When ritual changed from immersion in, to sprinkling of water, separate buildings were no longer necessary and small pedestal or wall fountains within the church itself became popular. These too were often richly decorated with marble, and exist today.

SOCIO-POLITICAL ASPECTS OF WATER MANAGEMENT

In this chapter, I'll discuss some ways in which water needs affected the structure of society.

According to Karl Wittfogel (1957), water management required collective human action necessitating the development of bureaucracies headed by a central authority. This social organization of hydraulic societies allowed for easy census taking, levying of taxes, and raising armies. However, it also provided a structure permitting the coercion of total populations into a labor force headed by this central authority, which assumed total control leading to the development of despotic governments.

Enormous courvees were organized in all major hydraulic societies, especially Incan and Egyptian, where all workers, from farmer to craftperson, were forced to participate in governmental water works. In China, prior to 221 B.C., dikes, reservoirs and canals made up an 800 mile transport canal utilizing one million workers equalling 1/2 the total population of England between the 15th and 16th centuries. At one time in the 19th century, the total population of Egypt was involved in irrigation works working four shifts day and night. After the Arab conquest of Spain an hydraulic society was established, funded by huge revenues from agriculture, which permitted installation of major irrigation works in systems of canals, aqueducts, reservoirs, sluices and dikes (Wittfogel, 1957).

Wittfogel suggests that societies organized for water management also contributed to developments in mathematics and astronomy. As early as 3,000 B.C. records of water measurements were kept to determine the amount of taxes to be levied (more rain--more taxes) and to collect data relevant for agricultural decision (Biswas, 1978).

Governments controlled water works. As early as Babylonian times, Hammurabbi's Code of Laws included a statement of water right holding each person responsible for repairs on his/her area of the dike or awarding payment to neighbors in case of flood damage.

During the Roman Empire a bureaucracy of about 700 workers managed fountains and aqueducts headed by a chief of water control, Frontius (35 A.D.), one of the most powerful and respected in government. Aqueduct channels, lined with hydraulic cement often leaked or were tampered with by a population reacting against Water Laws, which decreed that water was the Emperor's gift and had to be repaid. Therefore, no water rights were included with property rights, but had to be applied for and were granted only upon payment of a tax. Petitions had to be resubmitted upon the death of the property owner and could be denied by the government, thereby obtaining the family's wealth and resources. If the application was denied, the water supply was cut off, so farmers often punctured holes in aqueducts to deflect water for personal use, creating shortages in Rome (Morton, 1966).

Sometimes hydraulic societies developed into theocracies when the central authoritive power was imbued with religious power and symbolism. Otto Rank believed that people were intimidated into following the authority whose image manifested the will and grace of the creator, in the hope of achieving the good life.

Today, urban hydrology poses enormous problems for societies which may be met by public and private intervention. Hauser predicted that by the year 2000, 40-50% of the world's population will live in urban areas with no visible increase in water resources (Garstka, 1978). Currently, the U.S. alone with 6% of the world's population uses 40% of this non-renewable resource (Adler, 1973).

NATO's Advanced Study Institute on Water Resources and Land Use Planning advocate an holistic, ecological and global approach in an effort to solve problems of depleted urban aquifers, pollution and sewage problems caused by urban development, where high density urbanization has resulted in more paved surfaces limiting reabsorption of water into the land.

For example, high density urbanization and industrialization have resulted in more non-penetrable surfaces (increasing from 7.4% to 20.6% from 1955 to 1973 (Kaule, 1978) restricting water's natural return to the aquifer, thereby diminishing the supply of fresh water. Remaining resources are often polluted with high percentages of chemicals and

metals (sometimes 90-95% lead, zinc andcopper) from industrial and agricultural run-off which pollute rivers, lakes and streams, often seeping into the water table (Laconte, Haimes, 1978). Thermal increases in waste water from manufacturing, nuclear plants and air conditioning systems have negative effects on stream, river quality and aquatic life. In general our biosphere, the place in which we live, is becoming more polluted and less supportive of life.

Estimates of future urban water needs project increases of 60% for residential use (4 person families), 50% industrial, 20% commercial, 10% public and 10% loss. Projected need by 2020 is double the present supply in municipalities and triple in industrial areas, yet there is no apparent increase in water resources. A study (U.S. House of Representatives) indicates that U.S. cities could run out of water by the year 2000 and recommends instituting circular water systems -- re-use and recycling. (Shaeffer, Stevens, 1983).

Urban hydrology presents a fertile area for problem solving where artists can collaborate with urban designers and engineers to create water systems that are ecological, visual and recreational. Some artists have been addressing issues of urban ecology and are discussed in the chapter on contemporary fountains. Gyorgy Kepes (1972) has explored these issues outlining projects which are directed toward urban ecology suggesting environmental art forms which are aesthetic and

functional. He proposes "immense transparent structure(s) that give visibility to hydraulic processes. . . a ballet of water racing through obstacles of filters, tinted and unified by chemicals or moving sluggishly in intricate but legible patterns of transparent containers . . . Water purification sculptures could be framed with water gardens or water parks, providing an intricate interplay of all varieties of water movements and sprays in different densities and shapes." (Kepes, 1972).

He believes that as pure water becomes less available, "the more important it is to re-experience its richness within the urban scene."

Sheaffer and Stevens (1983) reported that U.S. cities might run out of water by the year 2000 pointing out the need to become aware water's importance in cities' future. The way in which water is controlled and managed will also affect city forms and social structure. Ann Spirn (1984) suggests an ecological approach to urban design focused on hydrology and topography as major issues in planning. She suggests limited development on lowlands, which have consistently deteriorated faster than uplands, leaving some of that space available for recreation, restoration of woodlands and perhaps water conservation and purification, systems which would permit revitalization of the urban aquifer (Spirn, 1984).

Water management can alter physical and social forms of cities and in some instances, towns have been created around

water management systems, namely Louvain La Neuve, Belgium and Lille, France, producing environments both aesthetic and functional, since fountains and pools wereintegrated into purification systems. A specific set of criteria was established: water taken from the ground should be returned to the aquifer, well water should be reused and reprocessed, run-off should be restricted and utilized, and water from these sources might be used for recreation. Fountains and artificial lakes were created by utilizing run-off as well as treated sewage which flowed into the lake and eventually into the aquifer, since the bottom of the lake was not sealed. After treatment, sewage water was usable for swimming and boating and the fountains were aesthetic and cooling. Water treatment plants in lagoons in Lille reduced E. Coli bacteria by 92% rendering the water safe for swimming and boating (Laconte, Haimes, 1978).

Since future cities will support denser population with greater need for water without visible increase in resources, new approaches to urban hydrology are essential. A study by the Department of the Interior recommends more investigation into the field of urban hydrology to discover means of manipulating urban waters toward aesthetics, water oriented recreation, transportation, agriculture and aquaculture. Fountains and water environments could be simultaneously aesthetic, recreational and ecological if some of the aforementioned experiments, such as new cities designed around

water management concepts and ecological water purification systems like those advanced by Kepes are explored further.

HISTORY OF USE AND DESIGN

Water has been thoroughly integrated into human life, necessary as source and substance of life, but serving many other purposes as well. It has been a symbol of birth, purification and death, playing important roles in religious purification rites. It is essential for health and hygiene; the bath becoming important not only for cleanliness, but socialization, recreation and politics. In addition, its role in festival and entertainment ranged from river festivals to fireworks and water spectacles.

In the following discussion I will focus on 2 major roots of fountain design, Persian and Roman, from which other forms emerged.

Fountains and water environments emerged from forms developed primarily from early irrigation systems. As each culture shaped water systems and fountains in the context of their particular societal need and climatic geographic limitations, diverse forms arose (figs. 8, 9). The design and character of these systems presented powerful patterns on the land as varied as the Nile Valley's system of ditches, rectilinear pools and canals, Aztec floating garden of Mexico, Roman aqueducts, and Persian quanats and pleasure gardens. Scarcity or abundance of water affected design and the quality of expression ranged from quiet repose found in Oriental, Persian and Mughal gardens to extravagant displays of water power found in Renaissance and Baroque fountains of Rome,

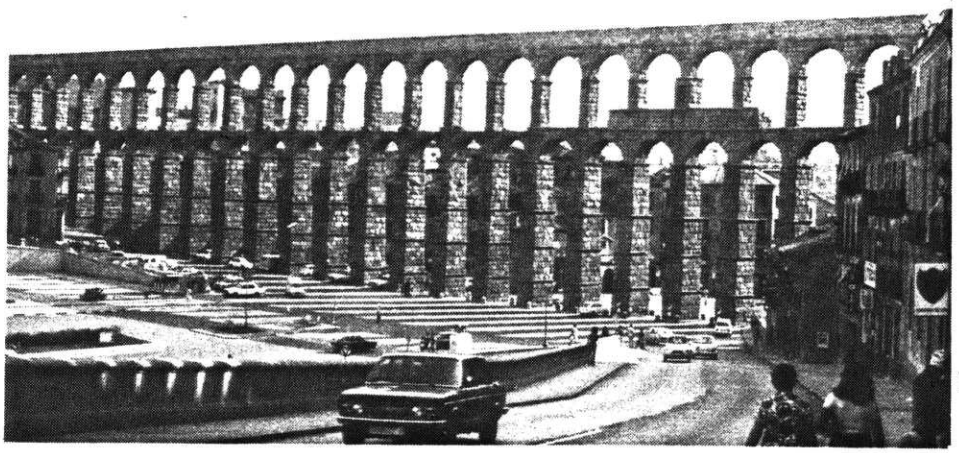


Figure 8

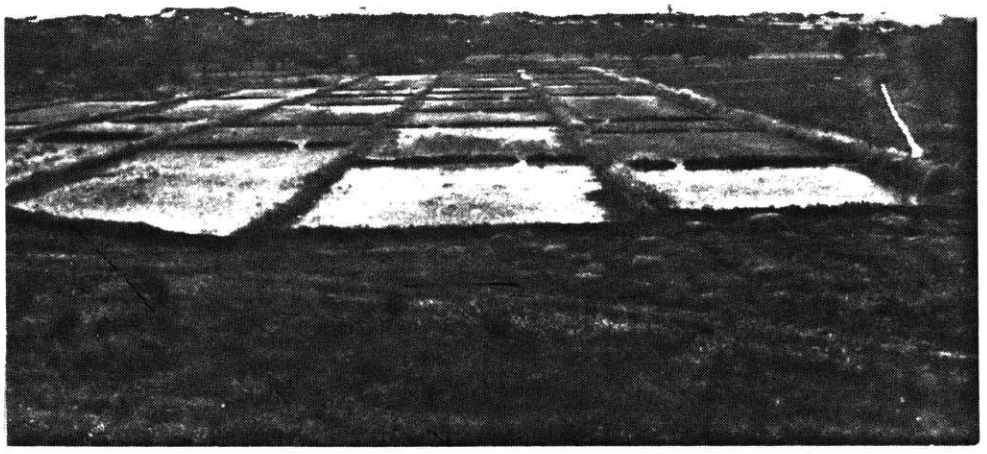


Figure 9

Frascati and Versailles.

Water has been an organizing factor both visually and politically. Increased population forced early settlements to expand into more arid areas requiring irrigation systems. In the following pages I will describe some of these irrigation systems.

One of the first irrigation systems diverted the Euphrates River, resulting in increased biomass which supported a larger population. This contributed to civilization's development in the Tigris-Euphrates valley (Lenihan, Fletcher, 1976).

By the time Babylon arose, a highly developed irrigation system permitted cultivation of terraced gardens or hanging gardens. These artificial hills of water proofed brick, lead and soil, were irrigated by water lifted from wells (Jellicoe, 1975).

It's believed that these gardens hung above a 75' structure of vaulted chambers supported by rectangular bases estimated to have been one-half mile square (Clifford, 1963). On these terraces vegetation, even trees were planted, the roots of which extended into pillars hollowed out and filled with soil. By this method artificial gardens were created which served both agricultural and recreational needs.

In ancient Persia scarce water due to limited rainfall, sometimes less than 400mm per year in some places, resulted in either aridity or floods when unpredictable rains arrived.

Quests for fresh water led to the development of irrigation systems composed of wells, canals and tanks, but open canals from the mountain source miles from Persepolis caused water loss from surface evaporation. An underground system of quanats, (tunnels 60-100mm in diameter and as long as 30 to 40 kilometers) was devised, sloping gently to ensure slow movement by gravity. Vertical shafts 20'-30' apart were dug periodically to clear obstructions (Legget, 1973). This kind of underground canal was later utilized by the Moors in the Alhambra where extended canal systems appeared and disappeared as water flowed from terrace to terrace.

Large cities in China's mountainous regions required adequate local food production, therefore adjacent mountains were terraced to retain water on each level for easily available irrigation (fig. 10). Terracing on lower levels permitted rice cultivation -- actually underwater - incorporating additional systems of dikes, dams and artificial lakes.

Egypt's minimal rainfall led to total dependence upon the Nile for all fresh water needs and as early as 7,000 years ago huge storage basins captured annual Nile overflow (Waterbury, 1969). Later a system of canals and basins along the Nile and throughout the Delta subdivided and criss-crossed the land. Often, water remained in these holding basins 40-60 days, to soften and permeate dry, cracked earth proving so effective that by 4,000 B.C. the Delta had become highly

developed agricultural area. These rectilinear systems, canals and holding tanks created strong visual patterns later becoming art forms in multi-purpose gardens, providing irrigation for flowers and fruit trees, as well as a kind of air cooling. Sound and color were important elements in these recreational environments which often had symbolic overtones. For example, abundant use of blue lotus symbolized the proliferation of existing life in water (Moore, 1957).

These linear and rectilinear designs, allow one to perceive these unambiguous lines clearly, and understand the structure of space organization immediately, (Newton, 1971). Even in the parched land at the Necropolis, in the Valleys of the Kings and Queens, evidence of rectilinear gardens once irrigated by Nile overflow is still apparent and is clearly seen in the landscape architecture of this garden at Thebes (fig. 10a).

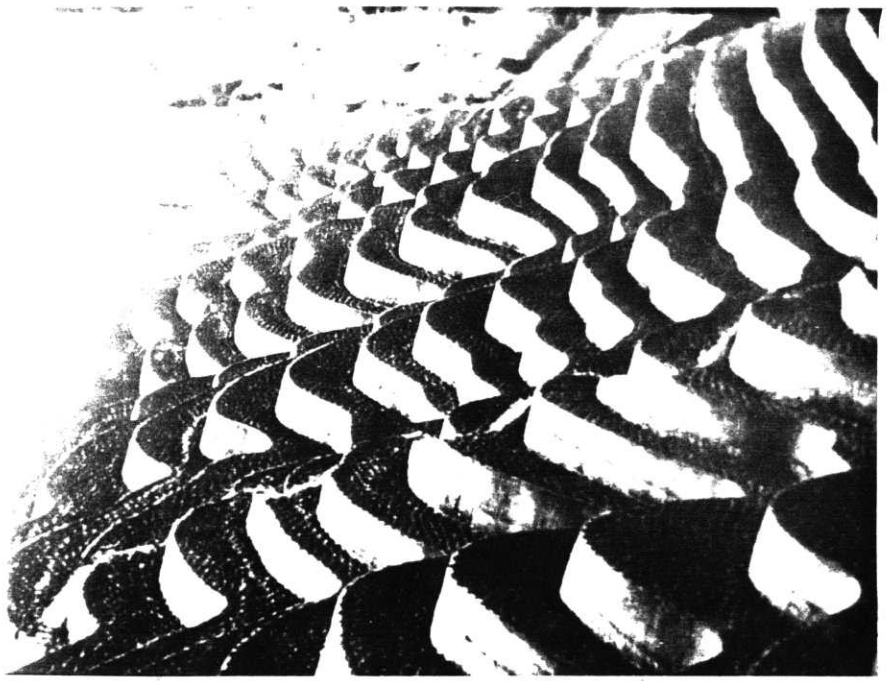


Figure 10

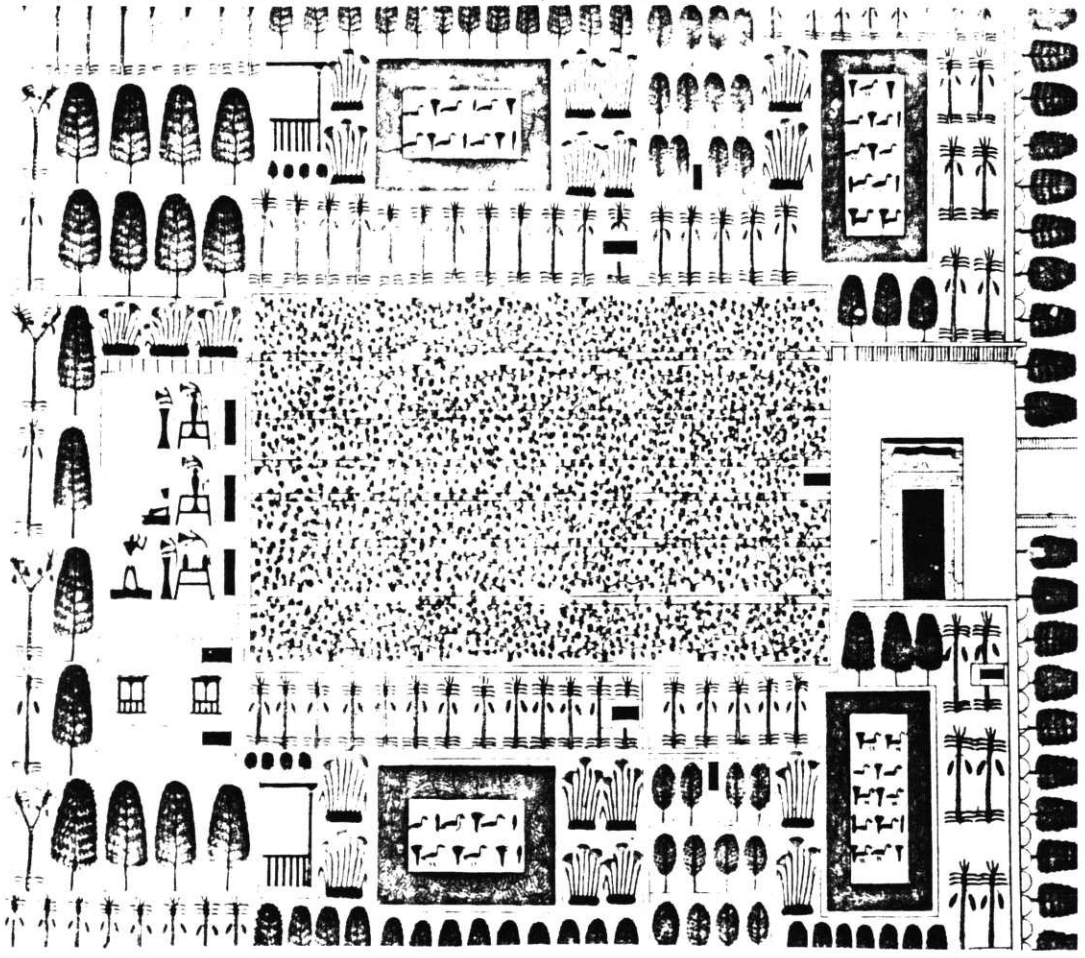


Figure 10a

Persian Influence

Influenced by Persian quanats and pleasure gardens, the Moors' multitudinous water courses at the Alhambra consisted of canals, pools, water stairs, water bannisters, (fig 11, 12) fountains and basins of varying geometric form.

When the Moguls invaded India they brought concepts of the Persian pleasure garden. Between 1483 and 1530 when Babur invaded India, becoming its first Mughal ruler, he expressed shock at the limited water supply in Hindustan, recording these impressions in his diary, the Babur-Nama. After analyzing Hindustani water needs he created monumental water works as resources for irrigation, fountains, gardens, bathing and recreation recorded in the following entries:

1525 to October 8, 1526 A.D.:

> Hindustan is a country of few charms. Its people have no good looks . . . no ice or cold water . . . no Hot baths, no colleges. One of the great defects of Hindustan being its lack of running-waters, it kept coming to my mind that waters should be made to flow by means of wheels erected wherever I might settle down, also that grounds could be laid out in an orderly and symmetrical way . . .
>
> The beginning was made with the large well from which water comes from the Hot-bath, and also with the piece of ground where the tamarind-trees and the octagonal tank now are. After that came the large tank with its enclosure; after that the tank and the talar in front of the outer residence; after that the private house with its garden and various dwellings after that the Hot-bath. Them in that charmless and disorderly Hindu plate of garden were seen laid out with order and symmetry."[6] (Beveridge, 1922) (fig. 13)

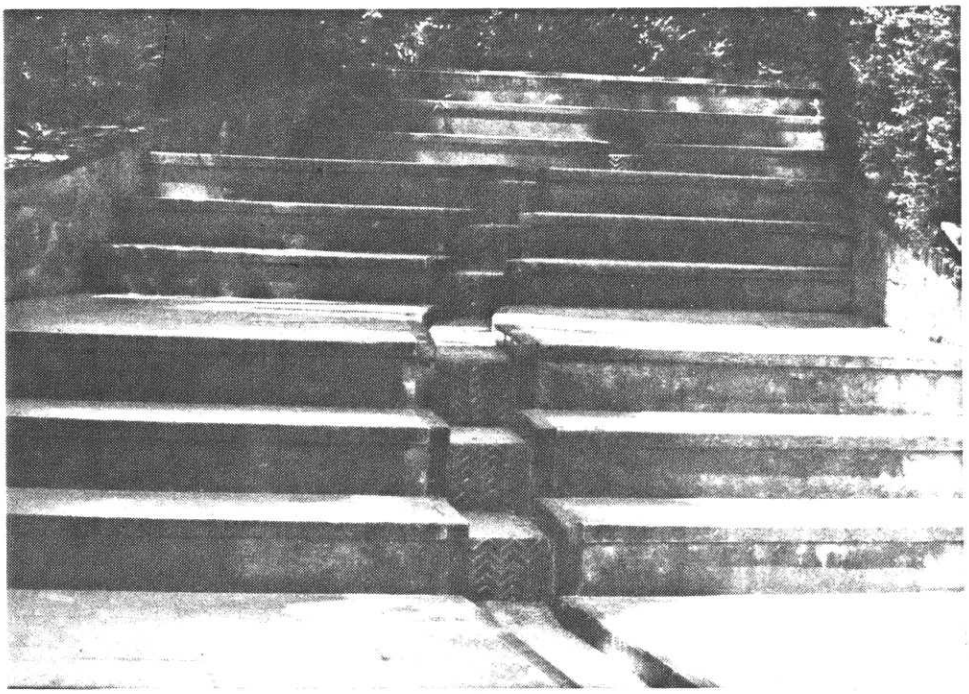


Figure 11

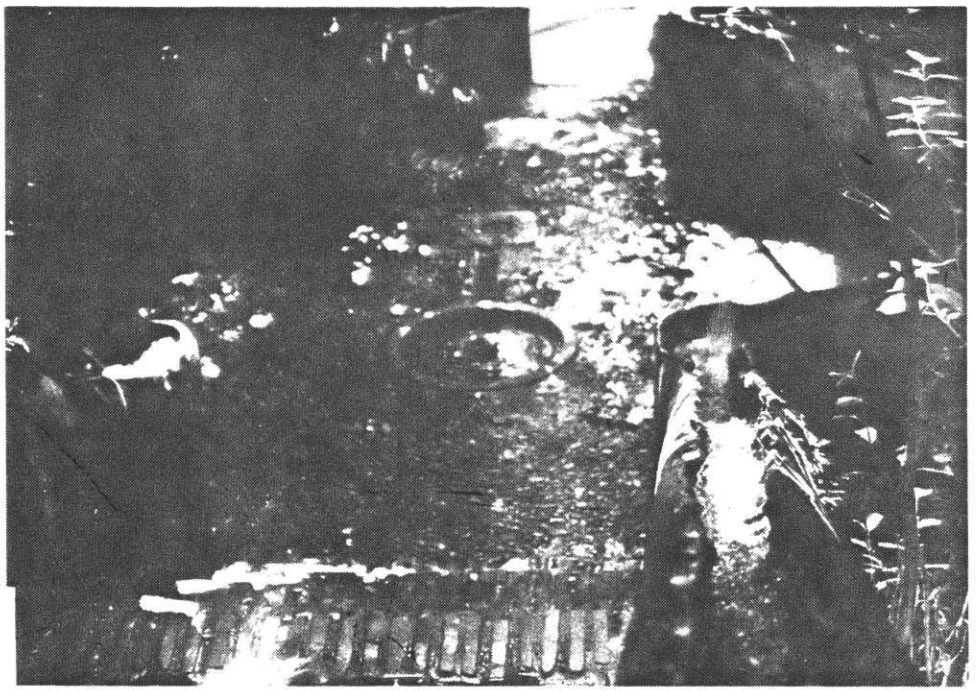


Figure 12


خوب می نماید خیلی باغ خوبی طرح شده و در طرف جنوب
کوه سفید نکنهار واقع شده در میان نکنهار و

Figure 13


گرداگرد حوض تمام سبزگزار
بانی چمن باغ همین است در وقت زرد شدن نارنجها بسیار

These fountains were based on Persian concepts of a pleasure garden first described in a Mesopotamian poem as pure land where sickness, violence or old age were unknown. The enclosed garden created intimate, sensuous spaces, suggesting the harmony of humans and nature similar in concept to the Garden of Eden. Necessary components of a traditional pleasure garden are: water for irrigation, display and sound, shade trees for shelter, flowers for scent and color, music (Campbell, 1978) appealing to the senses. These gardens invited participation while supporting an essential use -- irrigation.

Because water was scarce, piped in or channelled from diverted rivers, the Mughals used it economically. Designs consisted of low bubbly fountains and narrow channels, often carrying recycled water as at Pari Mahal, India where an additional channel beneath the main one served as part of a recirculating system (Moynihan, 1979). Recycled water systems differed from Roman systems, where aqueducts carried abundant water directly from its source to terminal points at fountains which (lacking holding basins) allowed all water to flow directly into the Cloaca Maixmus[1] and the Tiber River.

In Mughal India multiple fountains and beautiful water courses comprised of water stairs and canals flowed by gravity to and under marble pavilions. Many kinds of water were prod-

[1]Sewer System constructed by Etruscans in pre-Roman times.

uced for example, at Shalimar[1], surface texture produced foaming white water as it poured over a white marble water shute. Here also as in Chinese tradition, fountains were illuminated at night creating spectacles of fireworks and water - sometimes with as many as 400 fountains. (Moynihan, 1979)

Evolving from Persian roots, the Alhambra, begun in 1238, remains one of the most complete examples of Mudejar architecture and fountains creating a total environment containing a fortress and city, combining practical, asthetic, aesthetic, recreational and religious needs. Originally built by Nasrites as a palace complex, it was taken over by the Spanish monarchy after the Moors were expelled in 1492. Subsequent renovations greatly altered fountain design, so today many belong more to the Renaissance than the Mughal period. However, much Mughal quality remains and I would like to focus on those Moorish fountains.

At the Alhambra, water needs for irrigation, bathing drinking, washing, air conditioning and religion were supplied by the nearby Sierra Nevada Mountains, which were always snowcapped, even in summer. Water flowed by gravity through canals eventually down hillsides to irrigate orchards along the slope. Strong influence of the Persian pleasure garden exists in rectilinear pools, narrow irrigation channels and enclosed gardens (fig. 13 a, b). Hówever, the Koran's rel-

[1]Lahore, India, built 1633-1643.

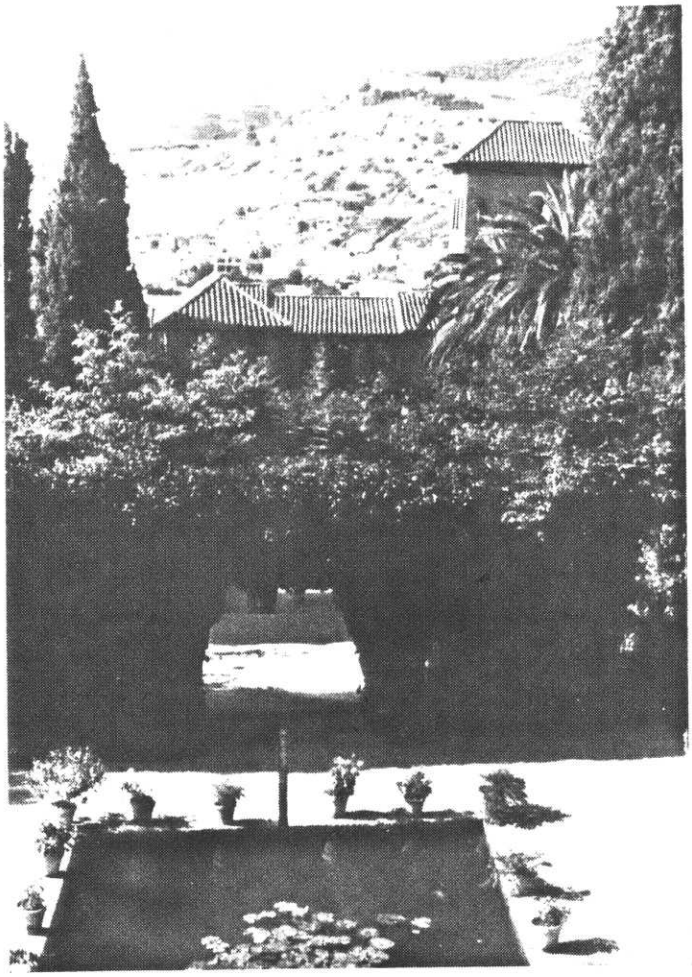


Figure 13a

Figure 13b

igious influence is evident in the absence of human representations and in ablution fountains kept filled to the brim. Water is used in a variety of ways; flowing, reflective as a mirror and playful, with light, represented by the following descriptions of three basic courtyards at the Alhambra.

In the Court of the Long Pond, (fig. 14) a narrow rectangular pool catches slender jets of water flowing in arches, mimicking arches of the adjacent building. Water breaks up into droplets which sparkle in sunlight like gems. Heavily scented flowers, oleander and roses surround the pool contributing to the sensuous environment created by the visual rhythm of repetitive water arches and the many tones of splashing water. Sound, an important element is often produced by multiple jets sending water to various heights as in the Court of the Sultana (fig. 15).

Persian roots and Moorish religious influence is evident in the Court of the Lions (fig. 1, 2) where a twelve sided marble fountain rests on the backs of twelve lions who gently spout water. This ablution fountain is always filled to the brim in accordance with Islamic religious principles (fig. 17). The patio, divided into four sections by narrow water channels, symbolizing the four rivers of life, are fed by low subtly bubbling jets placed along canals. Two, fed by fountains on an upper level, flow down water steps to the central basin (decorated with Arab inscription from an ode by

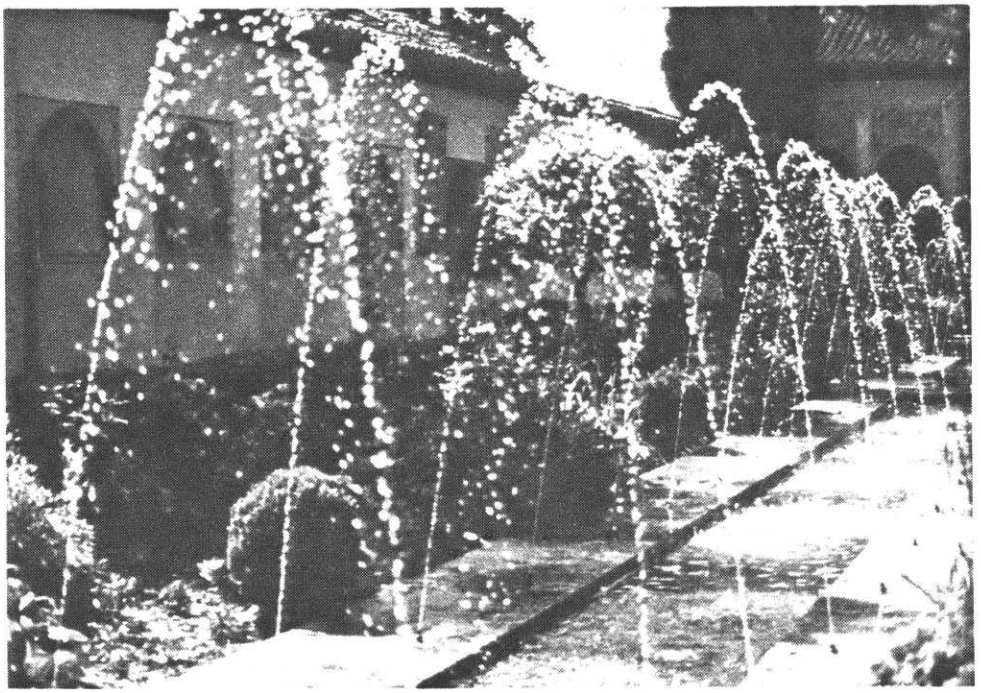


Figure 14

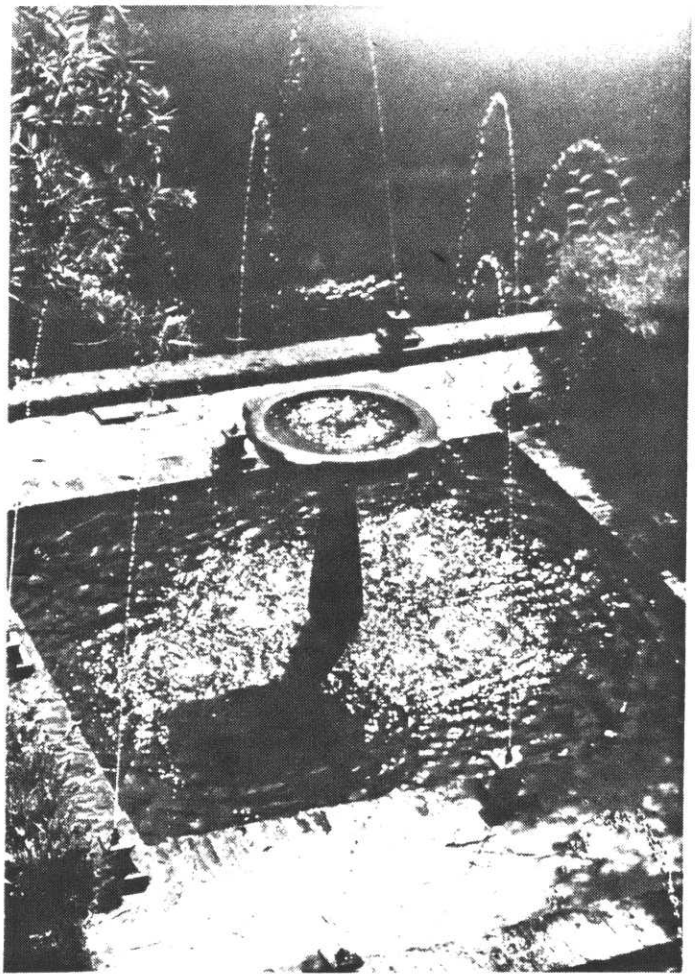


Figure 15

Ibn Zamrak.) Four rooms with decoratively carved plaster arches and porticoes supported by 124 columns surround the patio creating an atmosphere of harmony, providing visual, auditory and tactile sensation. Scent, sight and the sound of falling water from many fountains, the cooling effect of canals combined with visual images of fountains and architecture present a typical Moorish water environment.

Another room, the Court of the Myrtles, (fig. 16) features reflective water. An enormous rectilinear pool (37 - 24 meters) is fed by two low bubbling fountains. (Sanchez, 1984). Images of sky, sun and moon are reflected integrating the surrounding architecture; a tower and wall covered with complex carving and azulejos.[1] Space is extended upward and down so one sees in a single image within the pool - infinite, immaterial space (sky) and finite material (architecture). This environment creates a distinctly silent and reflective place where water moves but is also held captive.

The total environment is highly decorative with geometric carving, design in tile and arabic script which covers all surfaces. Each design is different and estimates number more than 150 existing different patterns. This div-ersity of design is also present in the form of fountain basins which are round, square, rectilinear, hexagonal or star shaped sitting low in Muslim style at the Alcazar, Seville, (fig. 18-21) or raised after later modifications and influences.

[1]Brilliantly colored geometric patterned tiles.

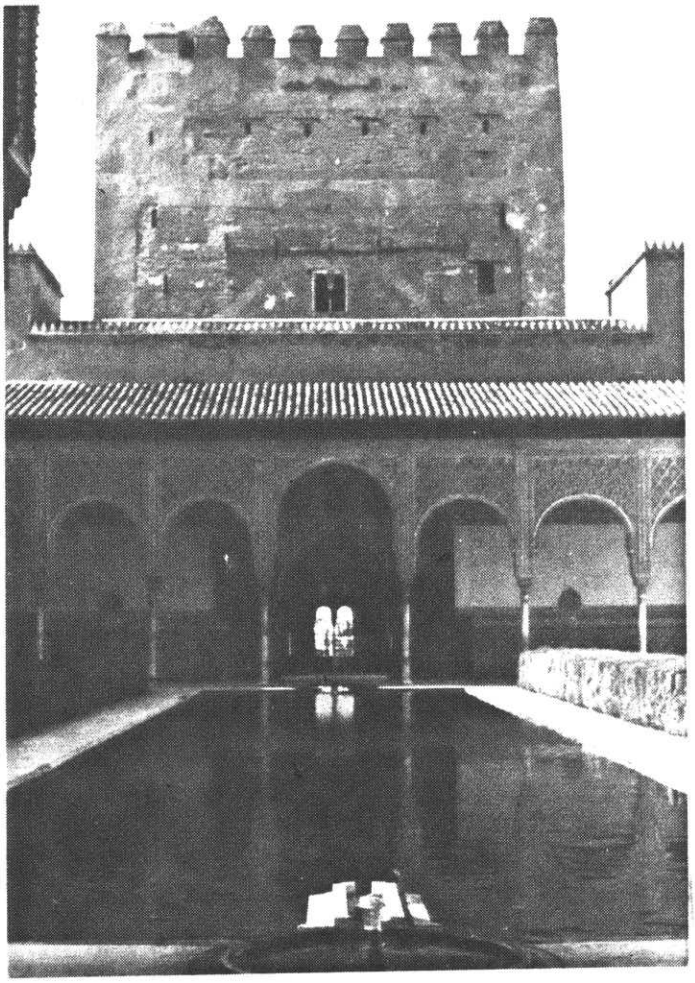


Figure 16

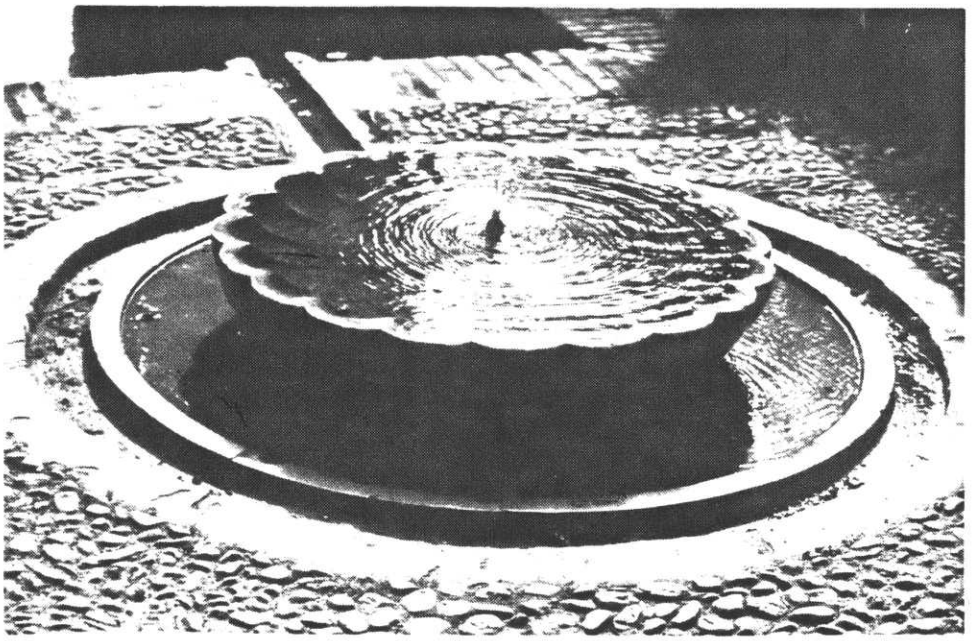


Figure 17

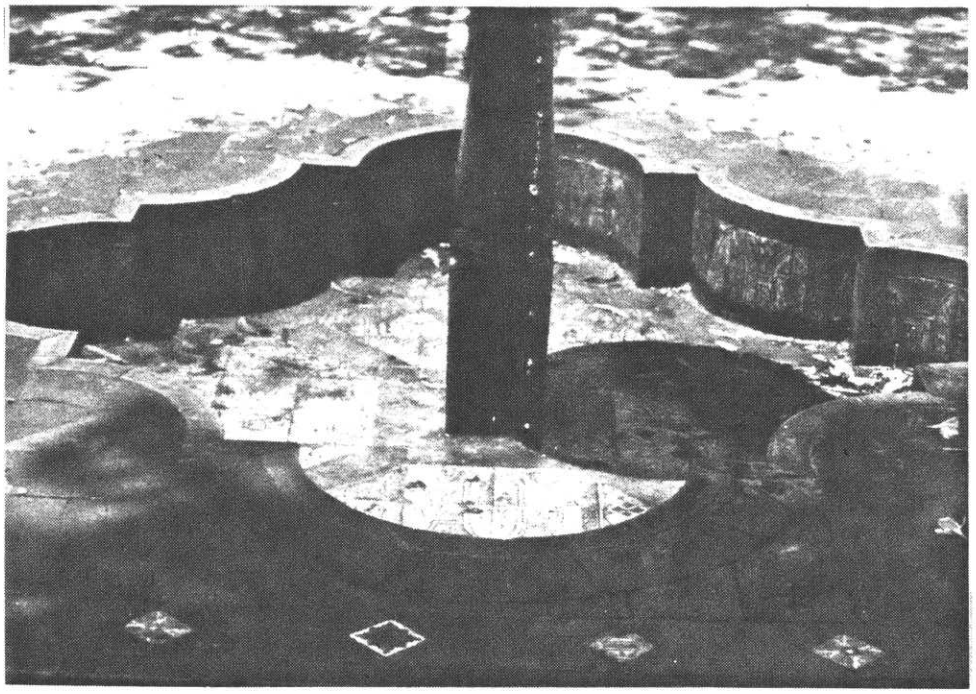


Figure 18

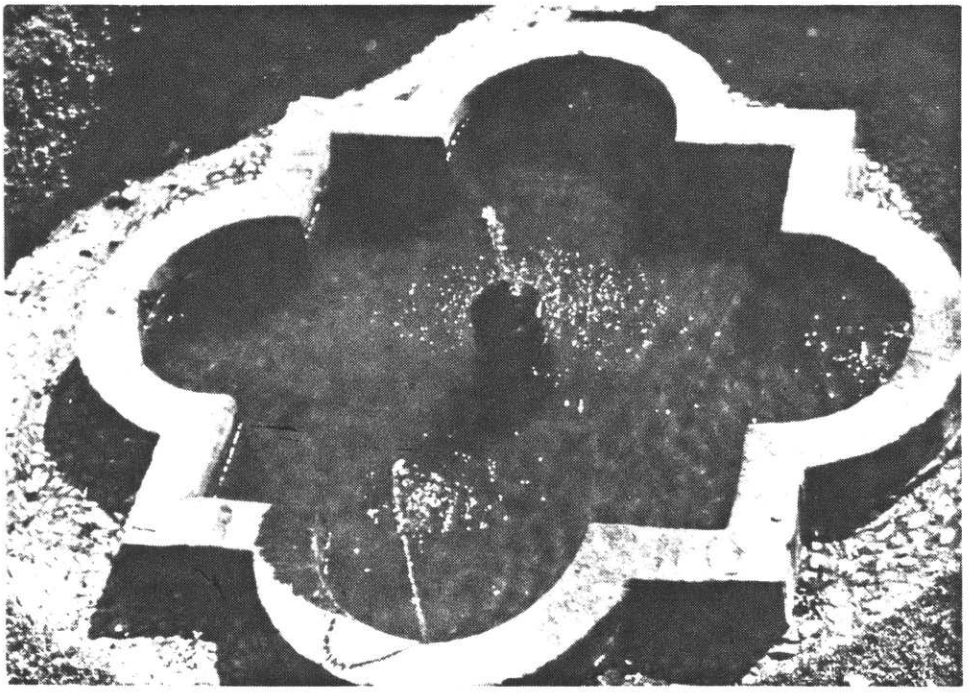


Figure 19

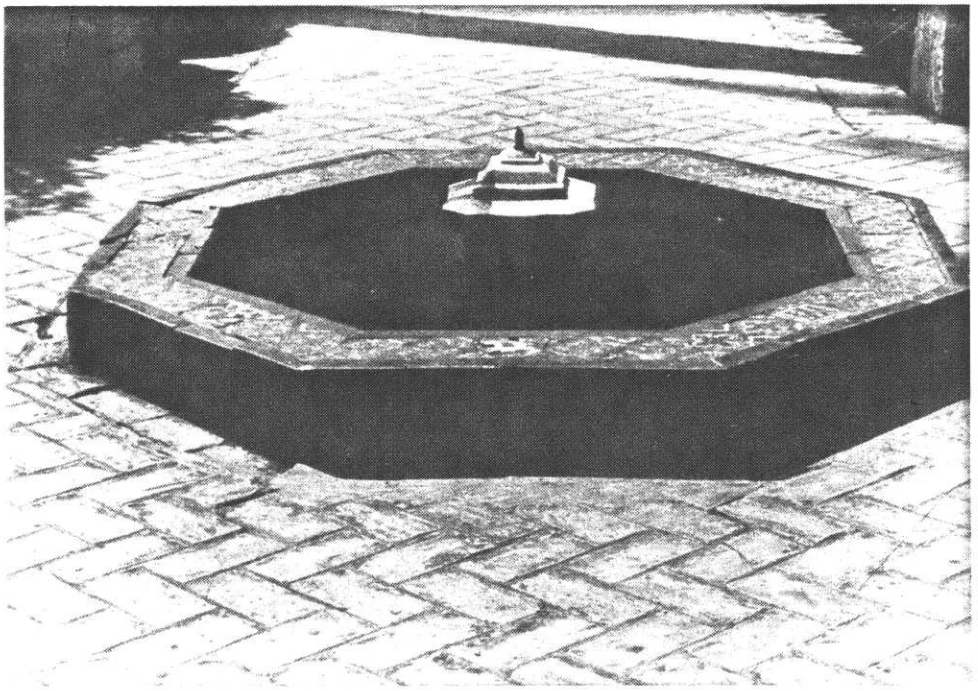


Figure 20

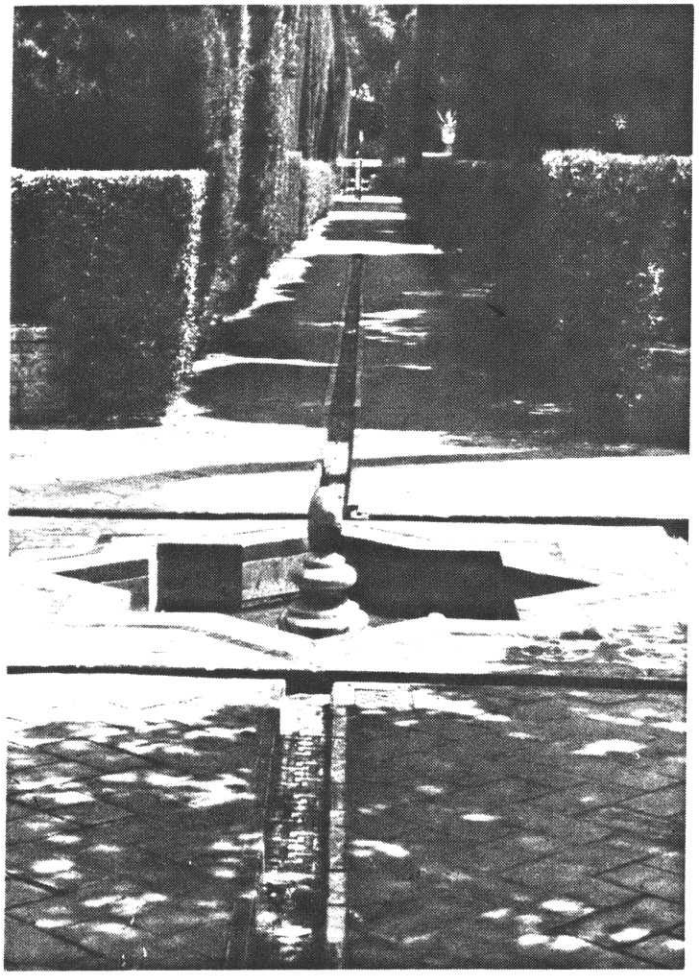


Figure 21

Both indoor and outdoor fountains at the Alhambra and the Generalife[1] exist within enclosed space offering an intimate environment filled with flowers, plants and trees; important elements of these water environments which served symbolic, physical and social needs.

Innovative designs such as open water bannisters ran to lower terraces inviting participation and offering sights and sounds relieving intense summer heat. (fig. 11)

[1]Summer palace gardens at the Alhambra, built 1319. Modified in 16th Century.

Roman Influence

In contrast to these contemplative water environments fountains derived from Roman forms display the power of water. After Rome's expanding population outgrew its water source from the Tiber River and wells, aqueducts brought an abundant and constant source of fresh water to the city. By 226 A.D., 11 aqueducts were built and by 640 A.D., 1212 public fountains, 11 imperial thermae and 926 public baths existed. (Campbell, 1978, Morton, 1966). Water from each aqueduct terminated in a fountain, although one aqueduct served many. However, these fountains had no holding basins, allowing water to flow directly into sewers and the Tiber River. This also served to improve health conditions as well as satisfy water needs. The waters from each aqueduct were kept separate from each other except in the fountain in the Piazza del Populo. (Morton, 1966).

Fountains also served important visual and entertainment functions as they were illuminated at night giving a festive air to the city. Great water spectacles were popular both during the Roman era and later in the mid 1600's. For example, enormous spaces, (what is now the Piazza Navona) were flooded for water games and chariot races to celebrate special festivals. In Rome and Greece baths for both men and women provided centers for sports, socialization and politics, with much care given to the design of monumental often luxurious structures (Campbell, 1978, Morton, 1966).

Cleanliness and hygiene were important considerations in Islamic, Greek and Roman culture where both private and public environments for bathing were highly developed. Ruins of Ostia (Rome's seaport) reveal private villas with plumbing and ducts for hot and cold air. Some of the most elaborate public baths in Rome were decorated with mosaics, marble and sculpture. Most well known are the baths of Diocletian, Trajan and Caracalla, comprised of separate places for sports, snacks, and socialization. These complex structures consisted of a frigidariums, often resembling a swimming pool with enough space to swim, a calidarium and a tepidarium, containing waters of different temperature as the names imply. The Thermae of Agrippa behind the Pantheon (Rome) housed a garden, fountains, clubs and restaurants. (Morton, 1966).

At the Alhambra too, richly decorated, but small baths are found on the lower level consisting of brilliantly colored mosaic walls and benches with overhead openings for light to penetrate. The environment was kept cool because of its placement on a lower level.

After the Industrial Revolution, public bath houses emerged, but later adaptations were more related to sports and recreation, such as contemporary clubs and swimming pools. One kind of architectural urban fountain in Rome was connected with religious symbol since it became "the place" dedicated to the water spirit. These public and private Nymphaea, extremely popular during Hellenstic times, were found in the

ruins of nearly every villa in Pompey. Often the form was that of a small domed structure with mosaic decoration and sculpture, but some contained complex hydraulic devices which forced compressed air into mechanical birds giving the effect of song.

New knowledge from astronomical discoveries[1] and explorations[2] led to an expanded view of human relationship to nature and the universe. People's sense of self was growing and changing perspectives (perspective was a new perception) of fountain art. A surge of fountain construction occurred with the rebuilding of Rome[3] when again fountains became focal points. In New Renaissance and later Baroque works sculpture often became primary, as in the work of Borromini and Bernini (fig. 22, 23). Complex fountains with multiple jets and varied images of human and mythological creatures spouting water also gave testimony to water's availability and importance. Bernini's[4] monumental fountain of the Four Rivers, while expressing the same these as the fountains of the Lions at the Alhambra, focuses on water symbolizing the power and continuity of rivers and oceans integrated with sculpture. Sculptural fountains point up a new focus on art.

[1]Copernicus, astronomer (1473-1543), Galileo (1564-1642), Kepler (1571-1630).
[2]Discovery of America (1492), trade route to the East (1486).
[3]Pope Nicolas restored Aqua Vergo Aqueduct 1453.
Pope Sixtus became Pope 1585 and initiated the rebuilding and restoration of Rome.
[4]Baroque architect sculptor designed approach to St. Peters, Multitudes of Fountains (1598-1680).

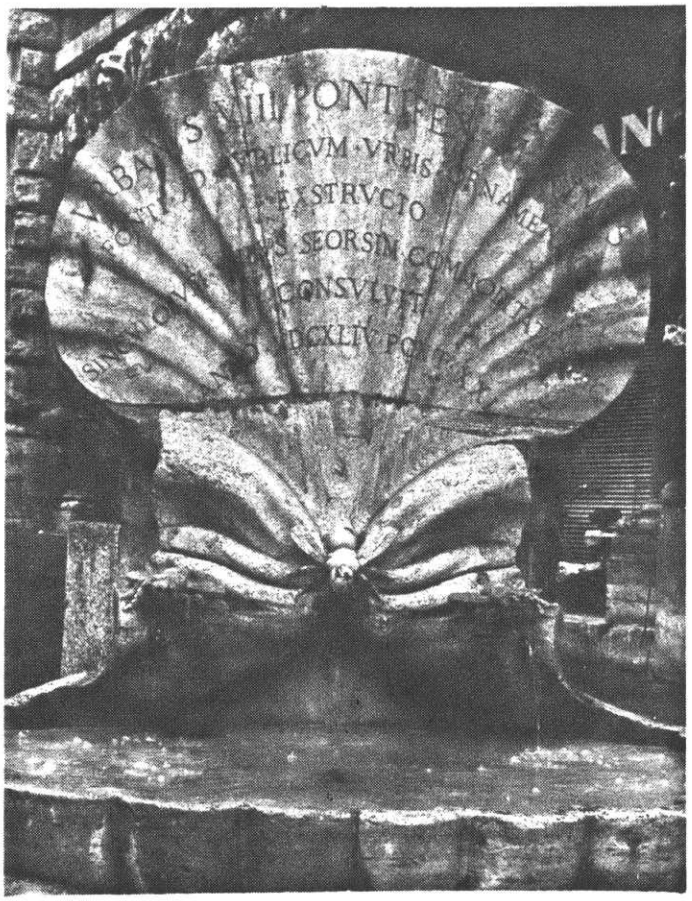


Figure 22

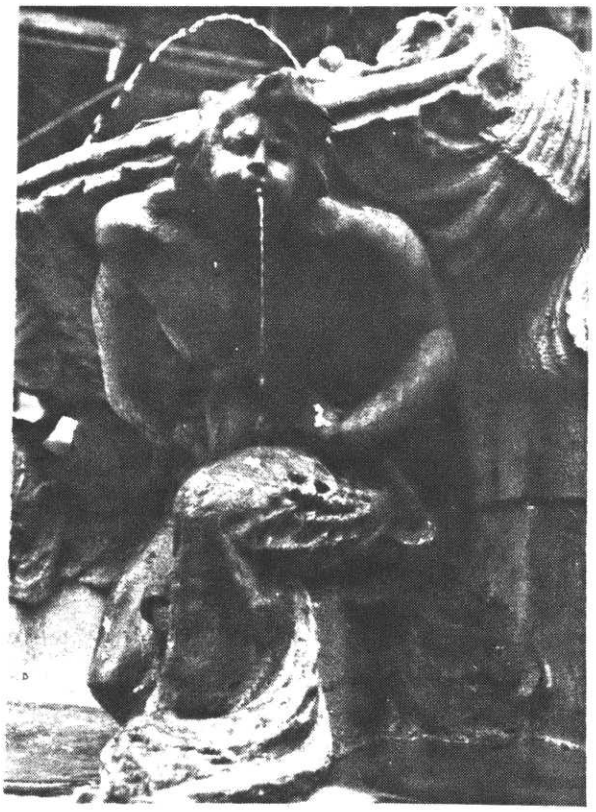


Figure 23

This is especially revealed in Trevi fountain where water rushes over rocks, horses, Neptune and Triton, all sculptural forms (fig. 24). This fountain is situated in an open plaza at the confluence of three streets rather than enclosed space s Mughal fountains.

Water environments at the villas of Frascati[1], with terraces, fountains, water stairs and bannisters, echo Moorish influence but in a different tone, presenting outward looking spaces filled with ebullient, wild, torrential water which pours down stairs, falls and banisters in a visible display of movement and energy.

A most unusual water environment at the Villa d'Este[2] presents water in many forms; flowing, falling and jetting. There, multiple fountains on many terraces produce complex images and sounds. Various forms include a circular fountain, an organ fountain producing sound hydraulically, water stairs, water "jokes" activated by mechanical devices which sprayed unsuspecting guests, water walls, pools and grottos. Although one does not have the sense of a Moorish garden here, certain elements were derived from the Alhambra and the Generalife; flow by gravity, water stairs, banisters, and terraces. However, sculptural elements appear also with water spraying from bodies, and the main purpose of this garden is recreation,

[1]Village near Rome, home of Villas Torlonia, Aldobrandini and others with elaborate water environments.
[2]Tivoli, built for Cardinal Hippolito d'Este by Pirro Ligorio (1550).

Figure 24

Figure 25

spectacle, display and humor, rather than contemplation, irrigation or religious ritual.

The fountains of Rome are too well documented to dwell on, but they contrast strongly with Moorish fountains. Roman fountains are predominantly sculptural and made of stone. I'll mention a few that are typically functional and recreational. La Barcaccia[1], (fig. 26) one of the most delightful, is a multi-use interactive fountain providing drinking water, sights, sounds, cooling and recreation. Semi-submerged at the bottom of the Spanish Steps it is easily accessible, a perpetual source of fresh water and a social gathering place. Shaped like a boat with water flowing from a lion's head, it serves as a public drinking fountain as well. Integrated seating provides places for spontaneous gatherings and a focal point for the 3 streets that converge at that point. In summer, people actually wade in the water, kept cool and fresh by constant flow direct from the aqueduct.

Throughout Rome, fountains are found on simple corners or spacious piazze, sometimes only simple spouts emerging from basic forms similar to hydrants (fig. 27). Even with available residential water, many people prefer water from fountains, believing that each aqueduct has a different flavor and quality.

[1]By Bernini (1627), The Boat.

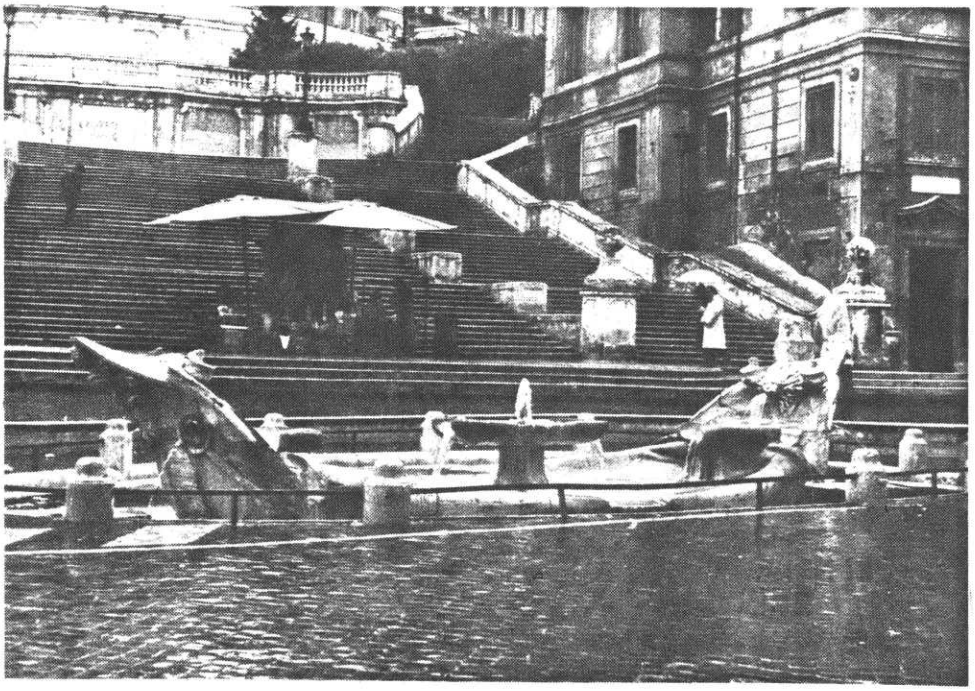


Figure 26

Figure 27

Fountains in Renaissance and Baroque Rome clearly dominated the landscape, situated dramatically as the central foci of squares (fig. 25). Often forms were vertical with obelisks (taken from Egypt by the Romans) contrasting with the strong axes of roads and buildings as at Piazza del Populo or Piazza Navona. Sometimes water in space assumed the characteristic of a wall similar in form to Portuguese fountains, becoming part of architecture as at the Pincio, the Pope Paul V fountain on the Gianicolo or Trevi. Each of Borromini's[1] Four Fountains sit in niches on four corners at crossroads atop a hill. There the fountains encompass total space, are visible when approached from any direction and serve as drinking fountains.

Renaissance fountains focused on sculpture with water appearing sometimes only as a simple jet but Baroque fountains displayed wild and rushing water activating strong sculptural elements. Sculpture was primary, sometimes assuming forms of tiered bowls, or natural forms, such as shells, bees, or fruit-all subjects of Bernini's work. His prolific output has filled Rome with fountains, visibly sculpture with water, creating images of water gods as well as fruit (La Pigna), objects (La Barcaccia) and water gods (Marfario), (Triton) and (Neptune).

[1]Italian Sculptor (1559-1667), Two male and two female figures represent four rivers.

Italian influence spread to France culminating in the spectacular display of fountains at Versailles designed by Le Notre. Laid out in a T with canals forming an East to West axis, the design emphasized geometric organization incorporating Persian elements in canals, pools and rectilinear forms. Italian influence is apparent in the lavish use of sculpture, tiered basins spouting water and mythological figures such as Neptune, Sirens and dragons. However, at least three fountains incorporate no sculpture at all displaying instead only powerful jets sending water sometimes as high as 90' (Moore, 1957).

The original marshy site adapted well to canals, the largest, 200' long and the flat land adapted to the parterre. Le Notre's concept, realized with the parterre, focused on developing an aesthetic and non-functional controlled environment. His emphasis on geometric forms were, according to Clifford, sympathetic to French concepts of rationalism and idealism. However, as in Frascati and Tivoli, the whole environment was created for entertainment and festivity with spectacular water and fireworks displays which were observed by as many as 20,000 people (Jellicoe, 1966). At one point, a Moliere play[1] was premiered with a backdrop of fire and fountains. However, these activities were to be observed rather than participated in and served to illustrate through sumptuous exhibitions of fountains, light and sound, the power

[1]La Princesse d'Elide (1664).

of the sun king.

In England topography and climate so differed that fountain and garden design were affected. Climate was damp, and land not as flat. Although early water plans followed Renaissance design, spaces were not walled and the focus was on use.

The canal system became fully developed as industry emerged. James Brindley (1861) engineered the first canal, later connecting East to West. Eventually a huge network of canals spread over the land, requiring locks and gates to function. Water tight enclosures with gates at either end permitted water release if the boat descended and water increase if the water level needed to be raised. With the 18th century, forms changed from an emphasis on straight lines to an emphasis on natural forms and romantic curves. Landscapes were designed to conform to nature and there was a shift toward activity and participation as primary uses.

New World Water Environments

Early American water works were also rooted in irrigation need shaped by geographical restrictions and societal influence. Some unique forms emerged, particularly in Mexico where the Aztec developed a kind of floating garden, Chinampas, on a lake, now the site of Mexico City. Requiring land for cultivation, the Aztec wove huge roots together forming a sort of mat on which 4 feet of soil was placed,

creating floating gardens which could be towed from place to place. On these 200'-300' long structures they planted vegetables, fruit and flowers which were protected by the lake serving as a natural moat. (Jellicoe, 1975).

Montezuma's palace gardens contained aviaries groves, fountains, pools, and artificial lakes filled supplied by an aqueduct. Water flowed through irrigation channels from lakes to terraced gardens providing water for arcades, cascades, baths and agricultural needs.

In their quest for water, the Inca created a bitumen paved road through mountains consisting of a system of underground aqueducts, canals and tunnels 6,500 kms long (Leggett, 1973). Garcilasso de la Vega described Cusco's sacred streams and Manchu Picchu's streets, built in the form of stairways with 16 descending fountains (Newton, 1971) and baths decorated with gold and silver replicas of plant life, replenished by water flowing through subterranean tunnels into golden basins.

North American fountains are few compared with Europe and most are based on European models often utilizing sculpture or tiered bowls with allegorical or historic figures. However, drinking fountains appear as bowls on pedestals or wall fountains similar to Iberian design.

After the Industrial Revolution, factories were constructed along rivers which provided water for machinery, easy transportation and waste disposal. Networks of canals and

dams were built in industrial England and New England, where new towns sprang up along these canal and river systems. For example, Holyoke, Massachusetts, one of several towns growing with the developing textile industry, used Hadley Falls as a water source to power cotton mills drawing 38cu.ft. per second to power machinery, and using the river for manufacturing waste disposal. This was also true in Lowell, where by the mid 1800's water was used at a rate of 30 cubic ft. per second and again the river (Merrimac) was used for waste disposal. This scenario persisted throughout Massachusetts as textile and other manufacturing developed with new and larger towns growing as a result of these industries. Not only textile industries, but coal conversion plants and paper mills also required large water intake (Armstrong, Ellis) as well as air conditioning systems in commercial and industrial buildings.

As a result of industrialization, urbanization, construction of dams and canals, the natural purifying processes of the hydrologic cycle were interfered with. Paved surfaces restricted water's return to the aquifer. Run-off often contains high percentages of chemicals and metals from industry and agriculture polluting rivers, lakes and streams, seeping into water supplies where nitrates and other carcinogens are found (Laconte, Haimes 1978).

Today, manufacturing industries require less water but newer industries, such as nuclear plants require enormous water supplies as do commercial air conditioning systems.

I.M. Pei has created an ecological solution for water needs at the Christian Science complex in Boston, by creating an enormous reflecting pool as part of the landscape architecture. It provides an aesthetic environment inviting socialization or private reflection.

Recently however, new trends have been appearing and since the 1960's especially, contemporary artists are shifting their perspectives, creating works that represent current thought expressing more holistic views of the world and focusing on interaction and recycling processes. Interaction is also a significant consideration in contemporary water environments. Halprin states that water's movement stimulated him to produce his participatory environments because one can be involved with it and use it.

RECREATION

Water is celebratory; popularly used in festivals and recreational events from King Henry VIII regattas on the Thames, to Boston's opening of the Cochituate Aqueduct (1848) to the Charles River regatta, to the Tall Ships' welcome, to world's Fair festivities (1965, N.Y.)

Although I've mentioned water's recreational use in previous chapters, I'd like to describe some other examples.

From descriptions of pneumatic and hydraulic devices invented by Hero of Alexandria, we assume that antique fountains utilizing these devices existed; none remain today. However, during the Renaissance and Baroque periods, elaborate mechanical devices produced fantastic water environments including water organs, singing mechanical birds and devices which tripped sluice gates spraying unsuspecting guests. One of the most extensive fountain environments in Italy still exists at the Villa'd'Este in Tivoli (see history). Here, a diverted river provided water for hundreds of fountains, terraces and pools, water cascades and water stairs producing an incredible array of diverse water forms and sounds. Although influenced by Mughal design, a different attitude was expressed toward water. Abundant water was celebrated in an environment dedicated to recreation, frivolity and decoration, rather than to irrigation or religious needs.

At Frascati, elaborate hydraulic devices, made possible artificial chirping birds and amusing artifacts. Artificial

wind moved a copper ball about 3' above the pavement re-creating nature's stormy, rainy environment. Water games, and frivolous water jokes, like Sicily's Charles III flooding his entire court, became popular.

Sometimes festivals related directly to functional aspects of fountains. According to historic accounts, when Swiss towns had to clean canals, an Autumn festival was held involving the entire population in this procedure. (Boufferd, 1973) Other festivals were held near springs to commemorate their religious significance.

Greek baths became, not only a place for hygiene, but places for socializing, conversing, talking politics and the Romans adopted this practice constructing numerous public baths and Thermae.

In the Orient, water festivities often incorporated fireworks, early predecessors to present light, sound spectaculars, for example, fire and water fountains of Agam, and the Fountain of Montjuich (Barcelona, Spain) by Carlos Buigas.

Water and fireworks figured largely in celebrations at Versailles where often 20,000 people attended theatrical displays. In 1664, for example Moliere presented La Princesse d'Elide within a circle of water, fire and fireworks.

One early Chinese festival required guests to compose poems while reclining by the edge of a canal, as glasses of wine floated along the canal. If the poem was completed by

the wine. Moore (1957) mentions a Chinese celebration to which honor the dead who lacked decendents. On the 15th day of the 7th moon, lotus shaped lanterns were floated on lakes commemorating past lives.

Water was used for show and frivolity. With the Baroque period came lavish use of water often in violent displays. Subsequent jets and water displays reached incredible heights with the jetting water reaching the following altitudes: Versailles 90', Chatsworth 94', Peterhof 120', St. Cloud 160', 19th Chatsworth 267' and Geneva 100 meters.

Today major cities like San Antonio, Texas and St. Louis, Missouri have huge, environmental water displays creating a sense of excitement and festivity, celebration and play in urban life, while also relating on another level to our awareness of movement and continuity.

CONTEMPORARY FOUNTAINS

Early irrigation forms created powerful designs upon the landscape becoming art forms shaped and modified by various cultures. Many contemporary fountains reveal roots in geometric and linear water courses of the Mughals or fountains with sculpture and rushing water as derived from the Italian Baroque, while others clearly represent contemporary ideas of process.

Carl Milles for example, continues Renaissance and Baroque tradition using sculpture as the fountain's prime element expressing traditional themes with traditional materials. His classically inspired mythological sculptures are executed in bronze or stone, (Poseidon, Diana, Europa and the Bull and Meeting of the Rivers) (fig. 29). Water and sculpture create monumental environments which with their dynamism capture a contemporary sense of movement. (Casson, 1930).

I'd like to mention a few other who use abstract sculpture as primary images, like George Tsutakawa, whose bronze or metal abstract constructions, comprised of verticle tiers, give a sense of upward thrust contrasted with the downward thrust of falling water. There appears to be more equality between sculpture and water forms, although the sculpture still predominates (fig. 28). George Hall's work, similar in form, used metal sculpture and splashing water but James Overhoff's work consists of a low stone form over which

Figure 28

Figure 29

a smooth sheet of water pours like a transparent wall. This piece is on a small scale but the use of water suggests natural water falls on a larger scale.

These works present individual images in space, like separate works of sculpture incorporating water and with the exception of Milles work are not environmental in nature (Bishop, 1967).

However, the influence of science and technology has produced a shift in thinking evidenced in the fountains of contemporary environmental artists. Just as the discoveries of America and Eastern trade routes changed the world view of the fifteenth and sixteenth centuries, exploration in space, science and technology have shifted our contemporary world view toward a greater awareness of ecological function within the biosphere.

Gyorgy Kepes (1972) suggests that the more we explore new environments and computers, "the more we are compelled to sense the interaction of man and the environment"[1]. That is the foundation of environmental art. New technological developments and knowledge reveal more clearly the interactive nature of the ecosystem, where all elements -- natural phenomena (weather, geography) and human beings with their constructs (industry, irrigation, building) affect each other. Ecology (derived from the Greek, OIKOS, meaning house or place

[1]Arts of the Environment, Ed. by Gyorgy Kepes, George Braziller, NY, 1972, pg.8.

to live) is concerned with relationships of organisms and their environment. Truly, our ecosystem is "home" for all human beings and we affect and are affected by all participating elements within this system. We all breathe the same air and use the same water. Our industrial creations produce waste, polluting our air and water supplies, marine and agriculture life, affecting the quality of our lives.

Environmental art is concerned with dynamic, interactive processes within the biosphere and the production of public art revealing principles of these often invisible relationships, where human, natural and artificial systems interact. Scale is also a consideration. Water in great natural phenomena, such as Niagara and Victoria Falls, lava fields of Italy (Flegrean Fields) and Iceland, steaming geysers like Old Faithful or Mts. Vesuvious and Aetna (Italy) inspire contemporary environmental artists. Many works depend upon the action of weather, temperature, wind and light like the art of Piene, Haacke, Nesjar or Klein, for example. Often these are manifested through the new language of technology and group process, which is more related to the contemporary world. Piene states that "environmental art results from the integration, or reintegration, of planning, architecture, art, media user participation, and - in all of these - modern technology" (1976)[1].

[1]Piene, Otto, article in Environmental Art YOU ARE HERE, Boston Celebrations, CAVS, MIT, ICA, Boston, 1976.

Environmental art relates to interaction, systems and the hydrologic cycle, a theme explored by many artists, such as Helen Escobedo whose work "RAIN TOWER" (Louisiana Exposition, 1984) recreates rain by sending water through cylindrical steel structures. Hans Haacke (Weather Cube, 1965) also reproduces the hydrologic cycle in small transparent plexiglas boxes, filled with liquid which evaporates, condenses and rains. Water changes states, revealing cycles of the hydrologic process (Burnham, 1968). In Ice Stick (1966) the freezing process is illuminated as a refrigeration stick frosts and freezes, changing state in reaction to environmental conditions, relating on a symbolic level to our sense of life's processes (Burnham, 1968). In this same vein, Carl Nesjar's all weather fountains become ice fountains in winter; programmed to permit precise amounts of water flow to insure stalactite development as water freezes (fig. 30, 32). Nesjar suggests that they must be functional and aesthetic all year and in Norway with particularly long winters they provide a fascinating changing display of frost, snow, ice and fog as the environment acts upon the work. David Medalla's Cloud Canyons (1964) create foam issuing from boxes of soap and water. Which are activated by machinery but their immaterial and everchanging forms are dependent upon environmental conditions as they respond to air, heat and light. Alexander Gonda's fountain (fig. 31) in Berlin however, is artificially frozen.

Figure 30

Figure 31

Figure 32

Similar in concept are works by Yaacov Agam which are also transformed over time, but incorporate other elements as well, such as fire and bubbles (Popper, 1976). His fire and water sculpture at the Museum of Modern Art in Paris displayed multiple jets producing constantly varied computer programmed water designs over which cones of fire emerged. These have qualities similar to early water spectacles in China and Japan as well as Rome and later Versailles, where water and fire-works were common displays for festivals and celebrations. These also relate on a symbolic level to primitive rituals celebrating gods of fire and water (Clemen, 1931).

Agam's sculpture often incorporate viewer activated transformations of images over time, manifesting his goal of enabling the viewer to perceive different views of reality (Reichardt, 1966). He states that his pieces are symbols of life's processes related to a Judaic sense of reality in the sense that each view is only a "partial revelation" of reality. His concept that diversity and multiplicity make up the whole is consistent with the oriental view of the many contained in the one and his work synthesizes historic attitudes with new knowledge of physics and technology. His bubble fountains create forms of limited duration by producing a continuous flow of bubbles controlled by spectator influenced electronic devices (Popper, 1976). He states that he does not want to produce works expressing a fixed state or use durable materials (Agam, 1979) in order to present varying

images offering a new perspective to the viewer whose participation in the work influences outcome.

Although not categorically fountains, these environmental art structures utilize water as a primary element communicating concepts related to process and the hydrologic cycle, where time is another vital element of the work. Viewers set Hans Haacke's work in motion. His "Drippers or Waterdrop boxes" (plexiglas boxes containing sections with small holes) suggest rain and natural phenomenon creating an appearance of the process of rain when the viewer participant turns the box over. Patterns, forms of droplets and flowing water are revealed, splitting and forming circular patterns. He also worked with boxes revealing processes of condensation and evaporation when heated. In a work entitled "Water and Wind", water was left on a Manhattan roof top to be acted upon by weather changes and the natural effects of wind. Haacke also explored ice-works revealing the processes of defrosting and freezing as well as steam and fog production (Gottlieb, 1976, Burnham, 1968).

In all these works object is not the primary element, but the pieces exist rather as prototypes illustrating processes related to water.

Greek concepts of the four elements, appeared during the Renaissance and Baroque periods and re-appear in the contemporary work of Yves Klein whose interest also lay in process. In his proposed project to climatize space, air, water, earth

and fire are combined to create a new purified Garden of Eden in which he called for cleansing the earth of all super structures and creating an immaterial architecture which climatized space. Four different spaces are separated by water and fire walls, with open air roof. Earth has been purified, removed of all human creations and structures and new systems are installed underground with only exit tubes above. Air beds and chairs exist, people are nude. Jets of water spray at a fire column. This plan was not realized but Klein's two Fire Fountains and Fire Wall were exhibited in Krefeld, Germany in 1961. (Gottlieb, 1976)

Joan Brigham a former fellow at CAVS, has been working with water in another state, steam fountains incorporating images from film or video. These images are projected onto vapor, which moves according to environmental conditions. Chris Janney, (also a fellow at CAVS) has created a sound element responsive to individual viewer/participant movement as another element of the steam fountain. Most recently, Brigham and collaborator Paul Earls, (another Fellow at CAVS), designed "Aqua Mirage" for the 1984 Louisiana Worlds Exposition, producing mist onto which laser images created by Otto Piene were projected.

Directly related to Brigham's work is the fog environment created for the Expo 70 in Japan by E.A.T. (Experiments in Art and Technology) based on a concept by Fujiko Nakai, whose fog environments were located at various sites at the

Louisiana Expo (Kluver, 1972).

Piero Manzoni's work also relied upon natural process over time to change the appearance of hydrophilic material which had been immersed in cobalt chloride and varied according to environment weather conditions (Gottleib, 1976).

Wen-Ying Tsai utilizes a strobe (invented by Harold Edgerton, MIT) to create changing configurations of moving water in his Cybernetic Water. This is activated by human intervention setting up a symbiotic relationship between the sculpture and the viewer/participant (Popper, 1983, Eletra, 1979).

Stephen H. Pevnick has created a computer programmed fountain also utilizing a strobe which created water droplets which fall freely from above -- The Rainfall Project.

Isamu Noguchi's fountains incorporate both nature and technology. His work has dual foci: fusing eastern and western concepts. A typical fountain exhibiting eastern influence is his water environment at UNESCO in Paris which represents a symbolic landscape of sacred mountain and sea, incorporating natural elements rocks, with artificial elements, concrete, to create a quiet contemplative setting. Related to this is his fountain at Chase Manhattan Bank, N.Y. consisting of a circular pool below ground level with natural rocks and concentric paving suggesting raked sand on traditional dry gardens of Japan.

Other fountains (Expo '70, Osaka, Japan) commemorate the

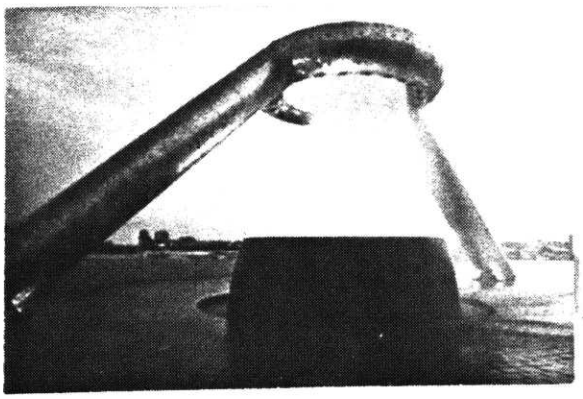


Figure 33

Figure 34

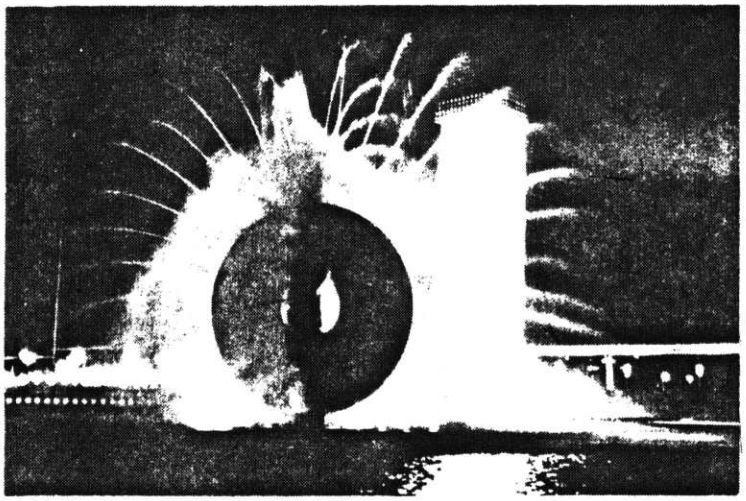


Figure 35

machine age offering images of power, industry and technology (fig. 34, 35). He stated, "I wanted to make a new fountain which represented our time and our relationship to outer space . . . a fountain is technology transformed . . . machine becomes a poem . . ."[1] He referred to the Dodge[2] Fountain as a "water engine" (fig. 33). Constructed of stainless steel, 24' high, it incorporates a computerized system to control light and water flow, varying from mist to a forceful, massive column of flowing water. Wind affects the misting fountains, so nature is also a part of these powerful machines systems. (Hunter, 1979)

Large environmental water projects related to ecology began with Olmsted's design for Central and Prospect Paris, N.Y. and the Emerald Necklace, in Boston (the first metropolitan park in the U.S., 1880-1890). Designed on a grand environmental scale, these visionary, yet practical plans integrated aesthetic, economic, conservation, recreational and hygienic concerns. A primary goal in the first project was to eliminate unsanitary conditions in Boston's Back Bay where sewage laden overflow from the tidal Charles River caused stench and flooding. He proposed a new gate at Charlesgate for tide control, drained marshes, designed a meandering stream through the Fens (1880) and planned a natural salt marsh planted with marsh grass to withstand the influx of salty water. Only one-half the land was to be a park, one in a

[1]Noguchi, Sam Hunter, Abbeyville Press, NY, 1979, pg.103.
[2]Hart Plaza, Detroit, Michigan.

a series of interconnected parks, (Franklin, Jamaica, Esplanade, Fens) integrated into the Emerald Necklace. (Zaitsevsky, 1982).

Hygiene and health for the city's population was Olmsted's primary concern hoping that fresh air within this network of urban green space would alleviate negative condition of city life. These parks were conceived as democratic settings for varied activity rather than only visual ornament. Yet, Olmsted deliberately designed for changing topography and vistas, incorporating artificial lakes, ice skating rinks, sheeps' meadows, bandstands, fountains for viewing and drinking, promenades, places for exhibitions and gathering places.

In Central Park, N.Y., topographical and visual considerations determined placement of an artificial lake in a low marshy area where the lake served as a huge reflecting sheet of water contrasting with forests along its perimeter. Fountains were designed for their sculptural content with high and low jets incorporated into the wall like TREVI, his stated model, yet the design considered practical and economic use of water from a nearby reservoir and skating pond, without which the fountains would not function. (Fein, 1972)

Other artists focusing primarily on nature have created huge water parks within urban areas accentuating thevarious qualities of water movement reminiscent of natural environments. In a sense they have re-created nature in urban

settings which invite human participation. Phillip Johnson's huge water park in Fort Worth, Texas, composed of falling and splashing water creates a series of water falls and fountains, where sound is also an important element.

Lawrence Halprin's huge interactive water environments in Portland, Oregon bring the qualities of water in the wilderness into an artificial urban structure. These are usually terraced to produce a variety of water form, flows and sounds, are truly interactive environments to be seen and heard, to be waded in, played in and even swum in. Halprin's huge sculptural forms invite lounging, sitting, and walking, creating a kind of theatre in which multiple event may take place spontaneously. Within a recently rehabilitated neighborhood in downtown Portland, he has created a 180' x 300' plaza incorporating multi-levels steps and ramps which encourages varied participation, creating a participatory water playground. (Halprin, 1968)

According to Craig Campbell (1978), innovations in interactive public water environments began with Lawrence Halprin's Lovejoy and Auditorium Forecourt Fountains in Portland, Oregon, both of which were conceived as environments for recreation plus play (fig. 36). Halprin's huge water environments simulating nature offer a kind urban wilderness, where water flowing over huge sculptural rock forms allow participatory or reflective experiences.

Attempts to bring nature to interior urban spaces is

Figure 36a

Figure 36b

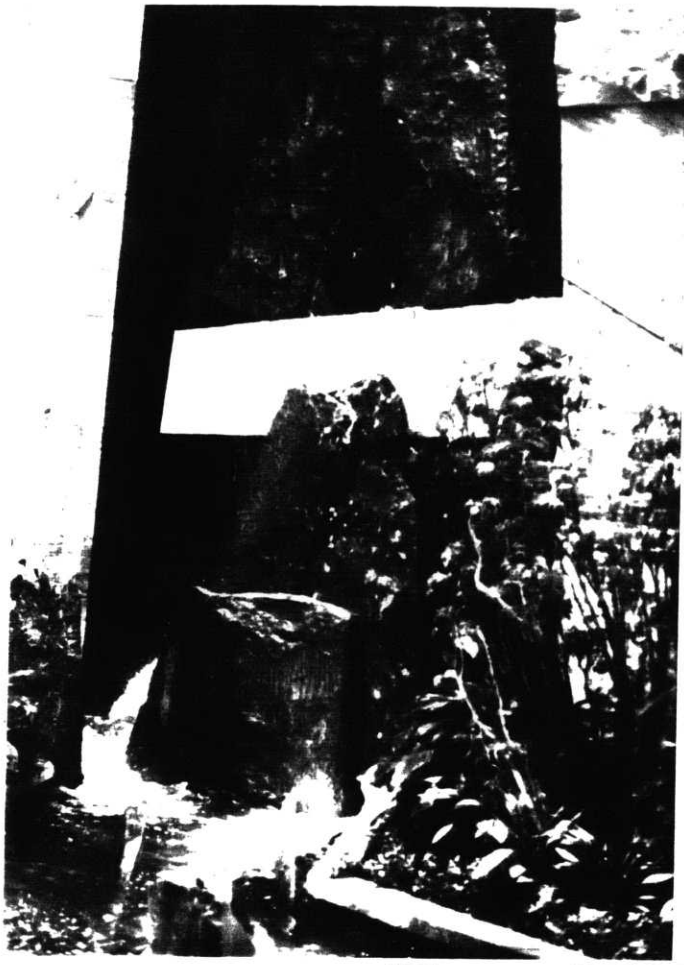


Figure 37

Figure 38

Figure 39a

Figure 39b

noted in the proliferation of waterfalls, fountains and artificial rivers, for example, Trump Tower, N.Y., and Copley Place, Boston (fig. 37, 38). Smaller pocket parks are developing, for example, a small (100') areas exist acting as oases within the city, Paley Park, NYC (fig. 39). Here an enclosed space between buildings contains a water fall shutting out city noise and creating a garden room. Although the huge wall of water is more in the tradition of Roman water use, this small enclosed space has some feeling of a Mughal garden.

I. M. Pei's environment for the Christian Science Center in Boston, used water in distinctly different forms. An enormous reflecting pool utilizing air conditioner waste water is derived from Moorish tradition. Slightly moving water in a rectilinear pool is kept filled to the brim at all times with a smooth edge allowing water to overflow into an external channel. This quiet contemplative place reflects the sky and surrounding architecture in a similar fashion to that of the Alhambra and is in direct contrast to the circular fountain at the end. There, water is powerfully jetting into the air under tremendous pressure forming criss-crossing streams that mist at the top when under full pressure. Then, too, the specific pattern of crossing water is apparent (fig. 40).

At the turn of the century many cities in the U.S. featured fountains as part of their central squares or parks,

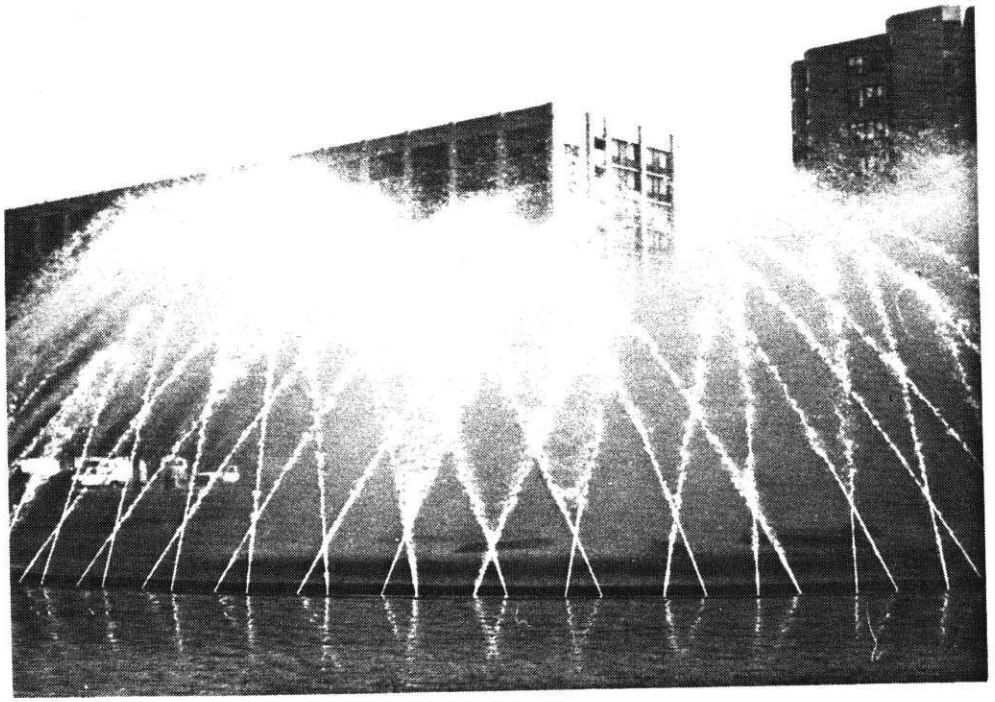


Figure 40

Figure 41

however over the years they were neglected. Often they took the typical form of Renaissance 3 tiered fountains, of stone or bronze supporting or supported by mythological figures or animals. Most drinking fountains were separate from recreational fountains and took the form of simple bubblers often on pedestals similar to Renaissance works or jutting out of walls, reminiscent of Moorish influence.

However, urban water parks of Spain and Portugal contrast sharply with those of the United States. While nature is re-created in both, volumes of water rush down rock-like forms in Halprin's and Johnson's work similar in mood to Roman and Italian baroque fountains. Quiet controlled water flowing in rectilinear forms derived from Persian irrigation and garden forms typify the linear water courses of Spain and Portugal (fig. 44).

In the Delicias Gardens of Maria Luisa Park, Seville, canals, rectilinear pools, myriad shaped low bubbling fountains profusely decorated with azulejos create images reminiscent of Moorish fountains (fig. 41, 43, 45).

A linear water course (fig. 41) within the center of Avenida da Liberdad, one of Lisbon's busiest streets creates an oasis where a sculpture of Neptune provides the water source for a long artificial stream flowing over low waterfalls and under small bridges (fig. 46).

A similar linear watercourse with fountains and 6" waterfalls line a boulevard in Madrid,(fig 47) and a series of

Figure 42

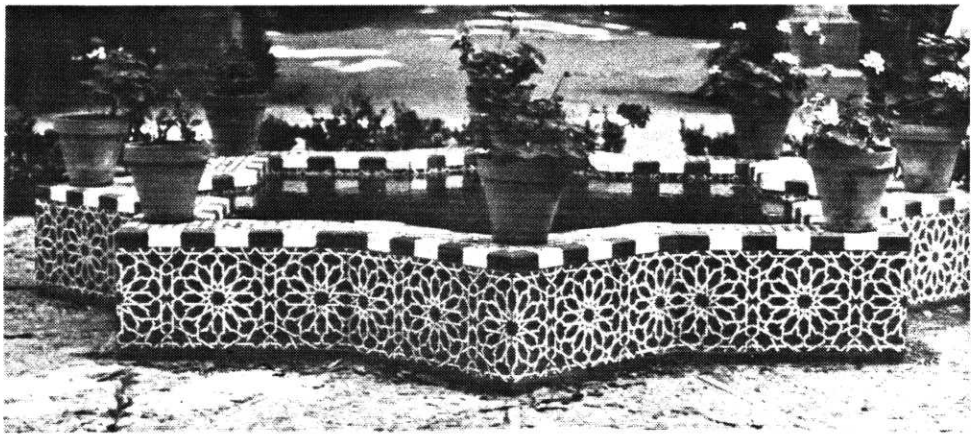


Figure 43

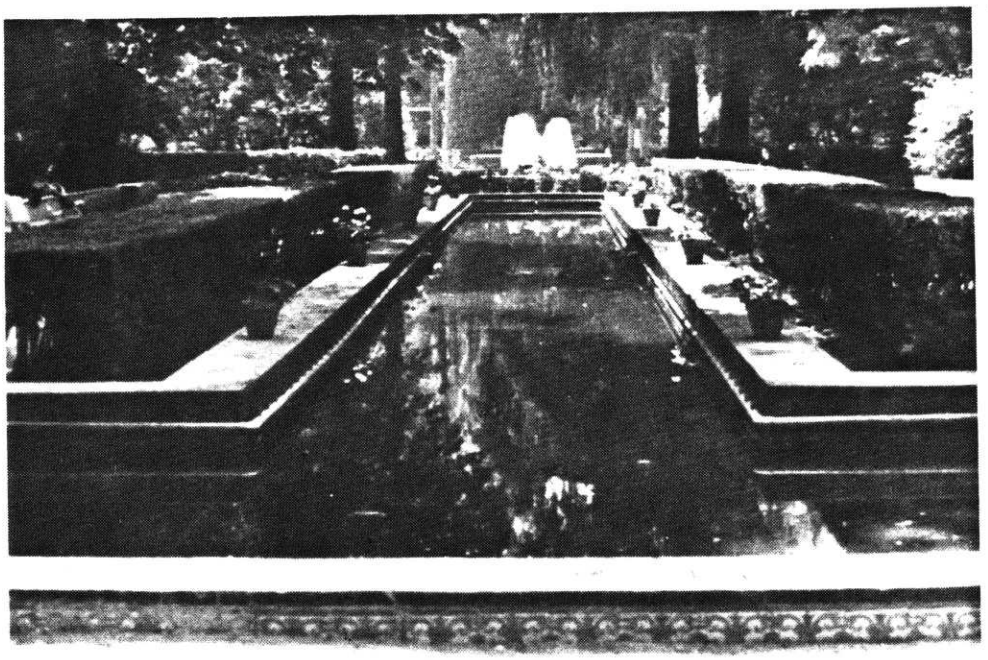


Figure 44

Figure 45

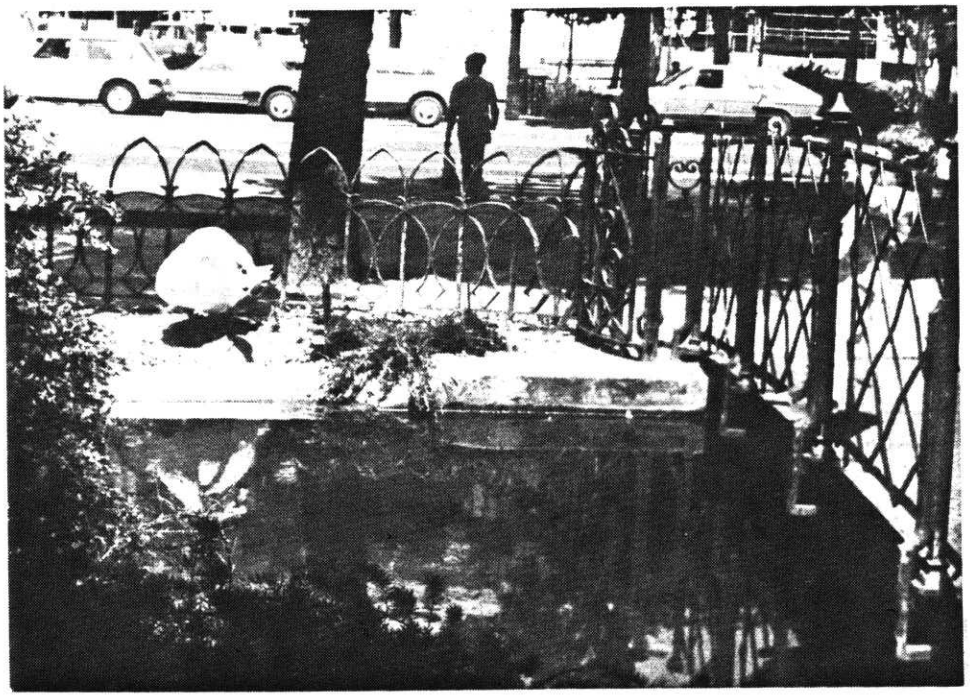


Figure 46

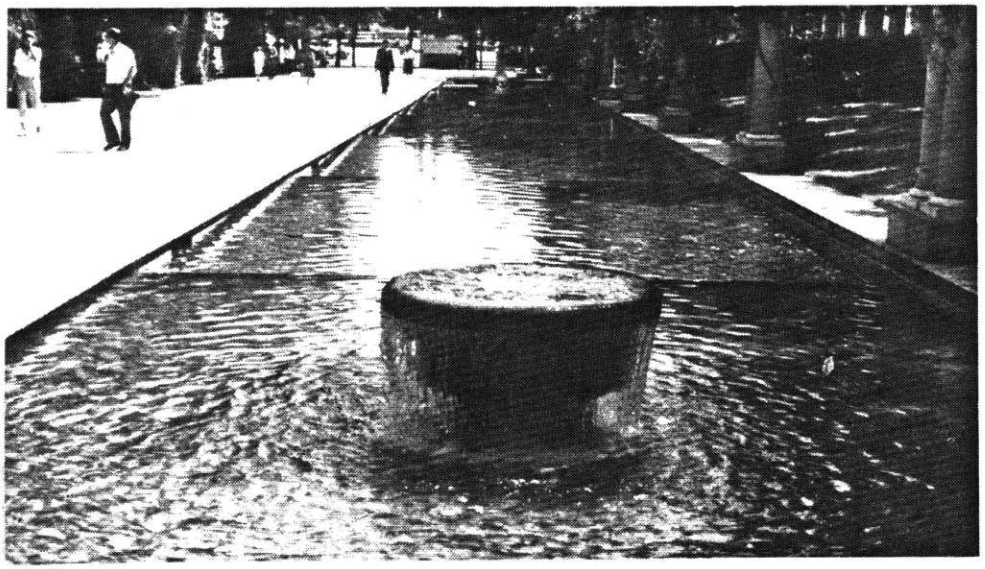


Figure 47

terraced fountains divide a highway in Toledo (fig. 48). Another linear design adapted to a contemporary city is adjacent to the Gulbenken Museum and a school in Lisbon, (fig. 51) where formal and naturalistic fountains and canals flow by gravity down a hillside in forms reminiscent of Mudejar gardens.

Others exhibit Renaissance influence utilizing sculpture as a prime element (fig. 42, 50, 54) while others utilize current technology to display several kinds of water flow as in Glorieta Marineros Voluntaria, (fig. 49) where mist, jetting and foaming water are combined. Misting fountains are abundant in Seville serving as visual, recreational and cooling environments. Cyclists and pedestrians enjoy the central fountain at the Plaza de Espana, which invites water play while others participate in boating in its surrounding semi-circular canal (fig 52, 53).

Another typical form of Portuguese fountain creates its own "place" by enclosing space with three walls covered with azulejos. Water flows from spouts along one wall often incorporating benches into the structure. Although an old form, contemporary fountains are constructed in this way both in the city and along roadsides (fig. 55).

Contemporary fountains following the tradition of water as spectacle are most completely realized in the fountains of Carlos Buigas, particularly the fountain of Montjuich, Barcelona. Buigas incorporates high technology, using comp-

Figure 48

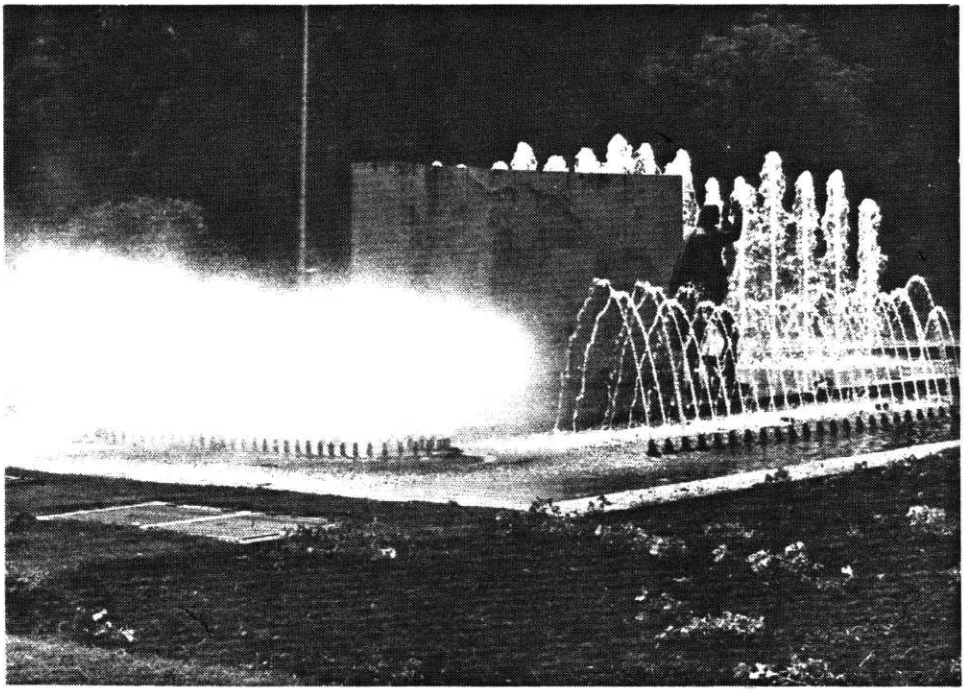


Figure 49

Figure 50

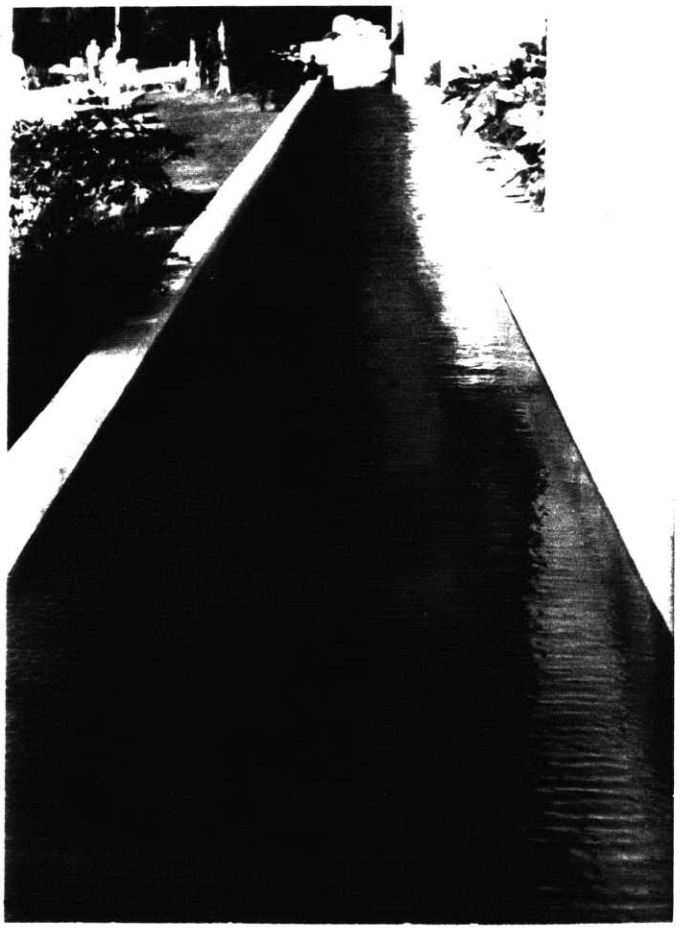


Figure 51

Figure 52

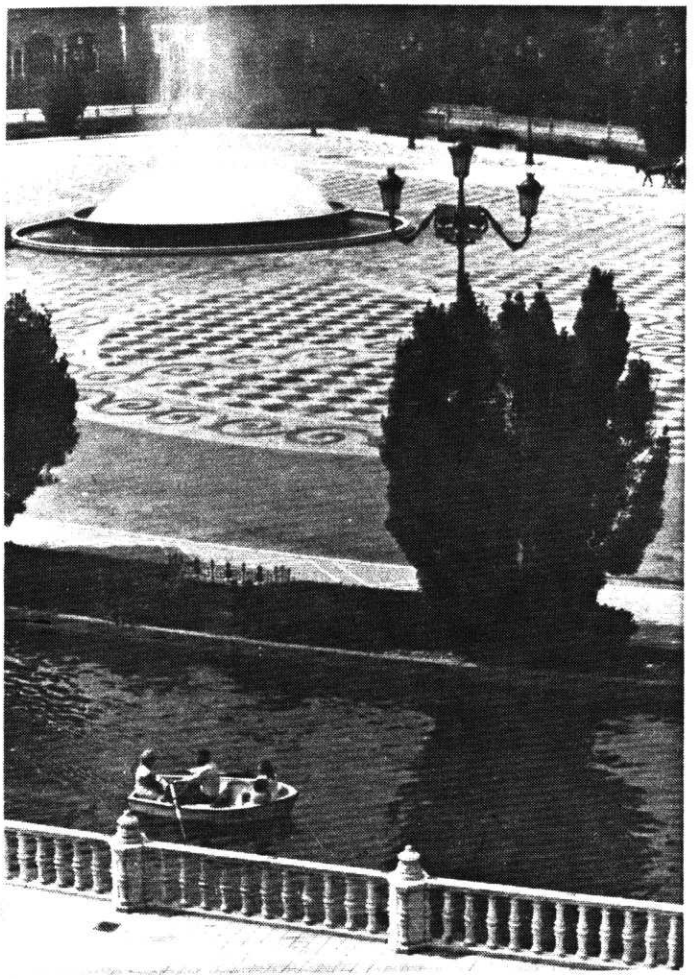


Figure 53

Figure 54

Figure 55

uters and high powered pumps to create spectacular theatrical water displays synthesized with light and sound. Computerized programs control infinitely changing water flow form, color and sound (fig. 59, 60, 61).

He relates the fountain to natural phenomena and processes, stating that water represents ocean, light represents sun and the fountains represent nature; its cycles and energy, which have been tamed by Buigas (Buigas, 1978). His attitude is consistent with traditional Roman and Baroque attitudes expressing human mastery over nature, however, his emphasis on process and transformation present a holistic, ecological and contemporary view of nature.

This fountain utilizes multiple systems of machines and technology to operate. It is run by four pumps sending 2,000 liters of water per second to 265 jets under 27 metros of pressure (fig. 63). An auxiliary pump sends 600 liters more to 125 jets when needed. Lighting is created by five pentagonal lamps 5' long using 500 watt bulbs covered with colored gels, programmed to revolve creating myriad colors and subtle change (fig. 62). Sound is taped, presenting all musical forms from classical, rock, to computer music which is often produced in the sound studio especially for fountain programs. All light, color, sound and water forms are controlled by computers from an adjacent building where 3-10 engineers program and operate this one fountain (Buigas, 1978) (fig. 64, 65).

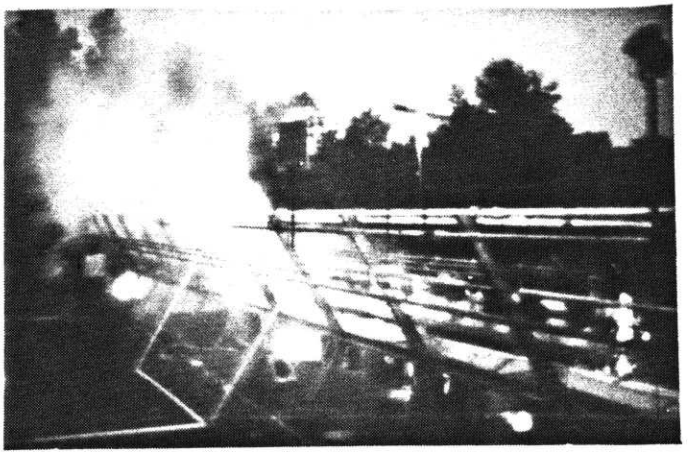


Figure 56

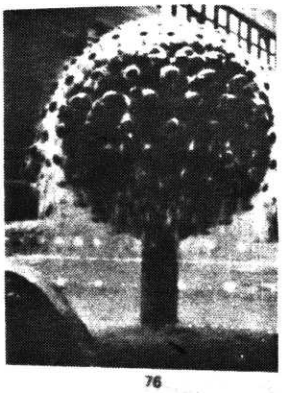


Figure 57

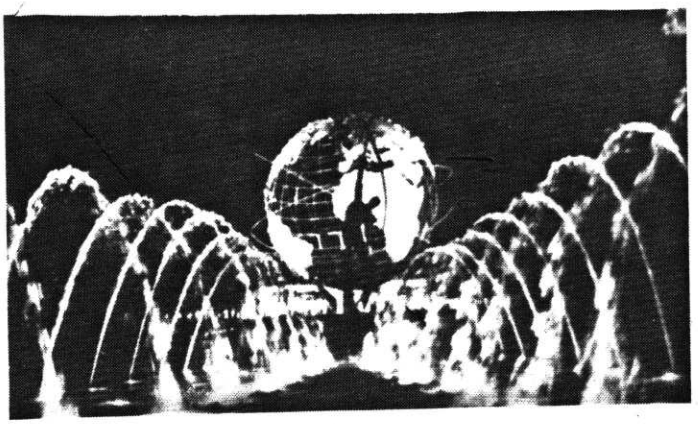


Figure 58

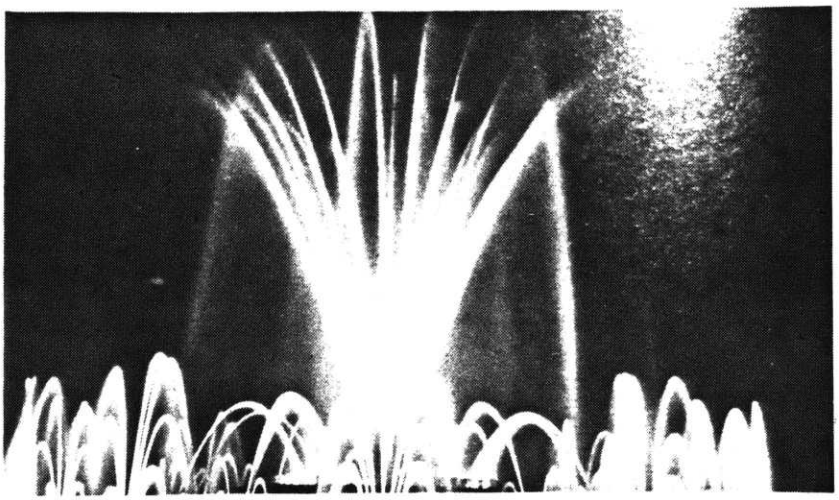


Figure 59

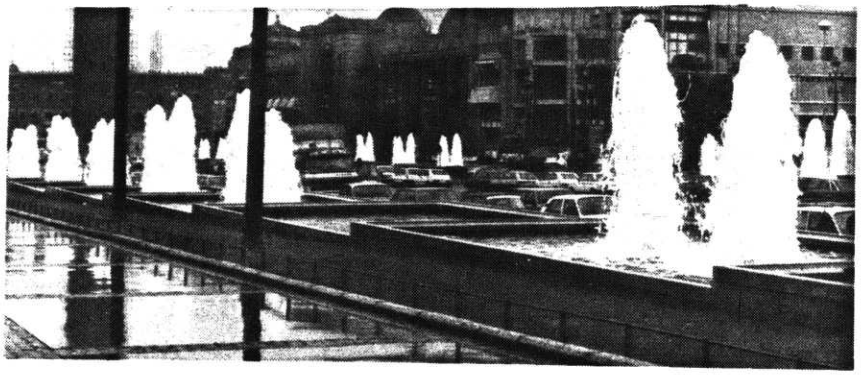


Figure 60

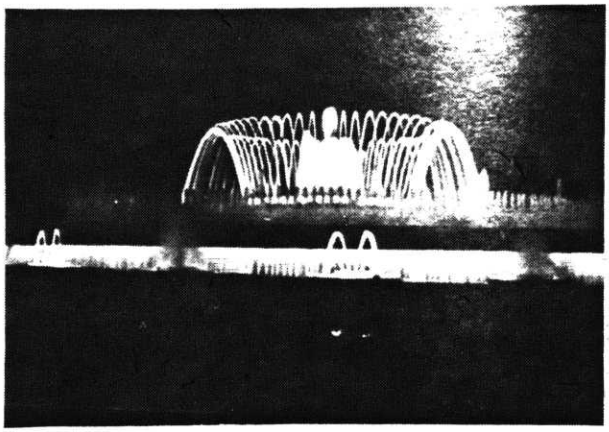


Figure 61

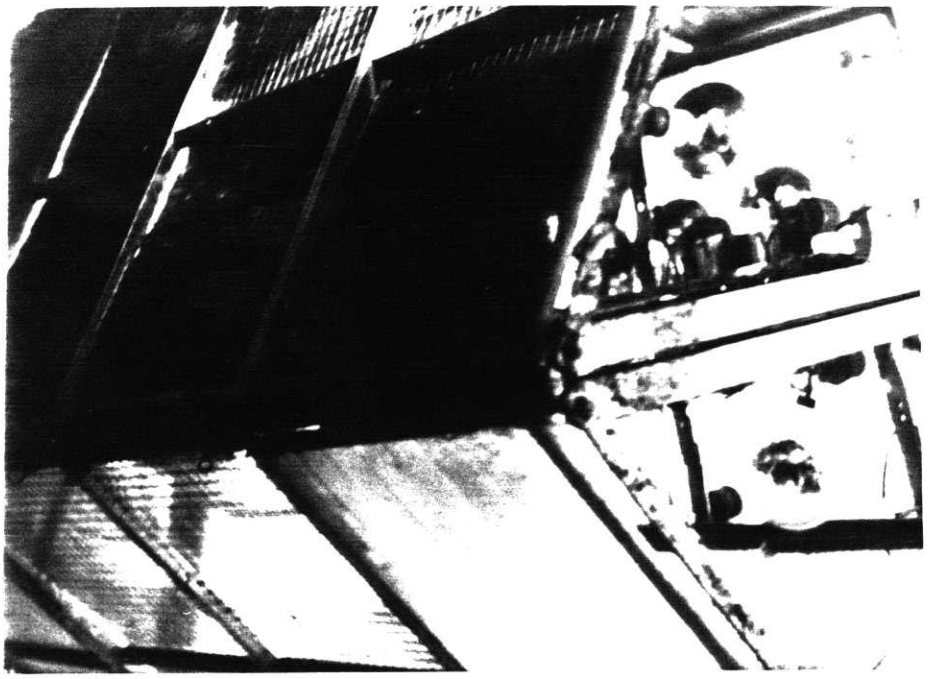


Figure 62

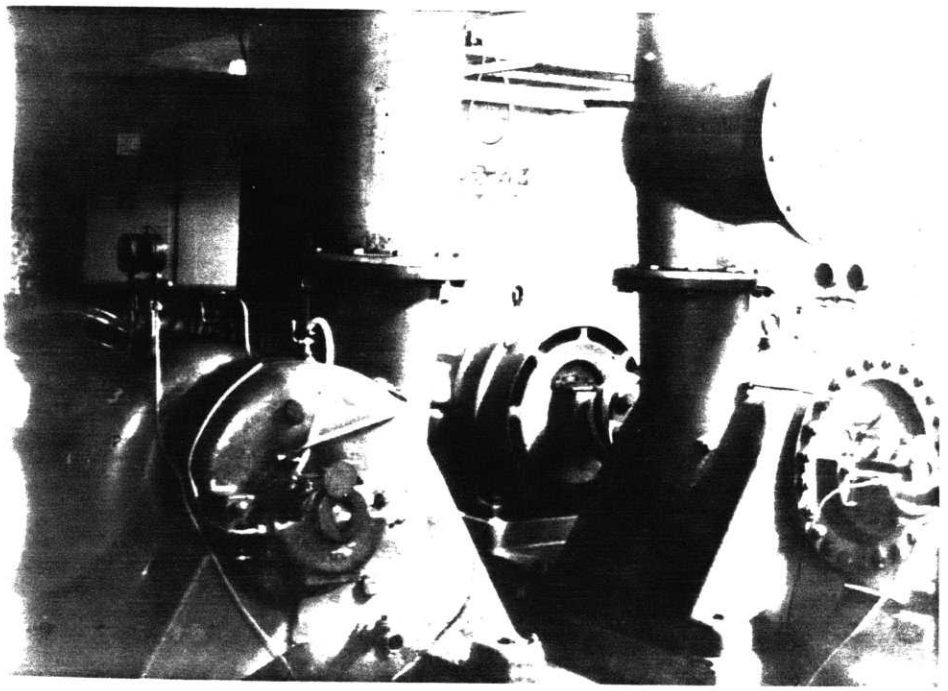


Figure 63

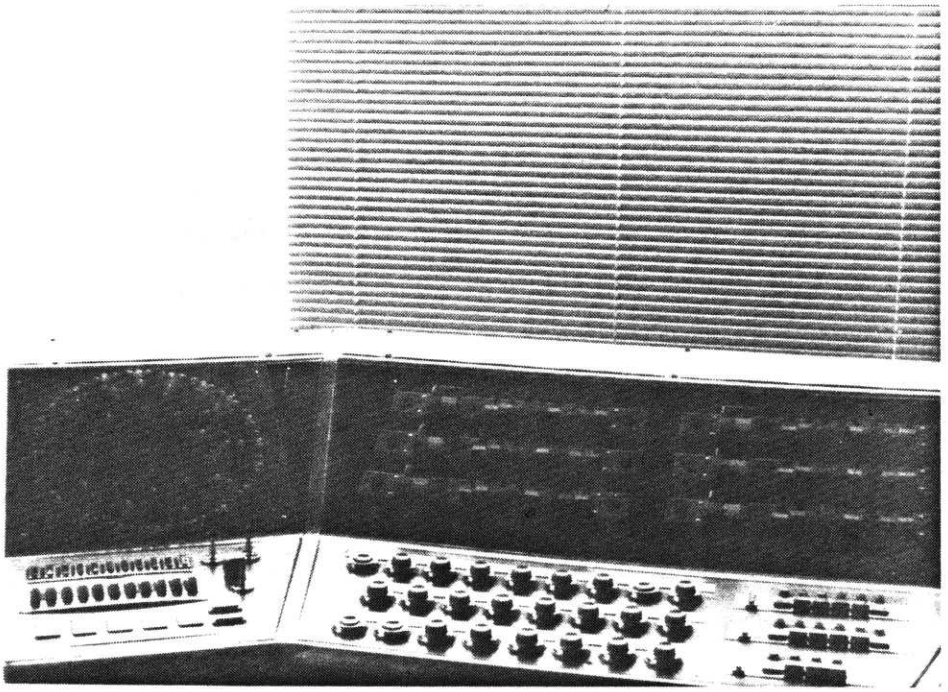


Figure 64

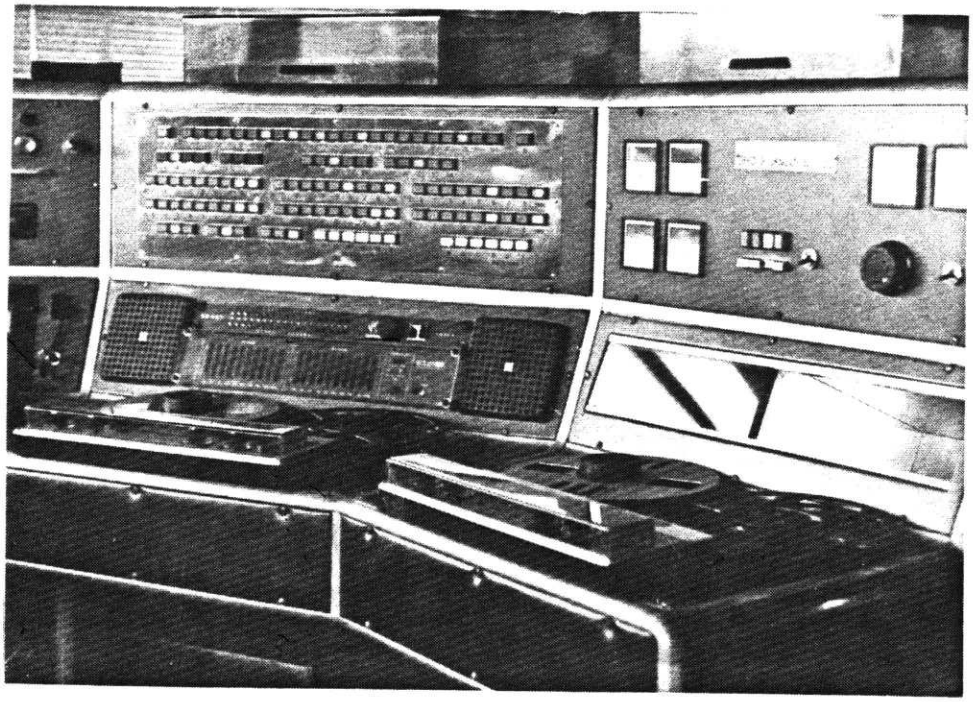


Figure 65

Other application of high technology made new kinds of recreation centers possible, such as those water environments in Oiso or Long Beach, Japan (Ross, 1978). There, computer controller mechanized environments reproduce various climates from tropics to deserts, offering such amenities as a 2,000 pool with mechanized waves which float people around artificial islands.

Other artists have directed their focus toward urban ecology. An experimental ecological stem designed by Herbert Bayer in Ottawa, Canada integrated urban water management with visual, recreational systems. Run-off was directed into an artificial pond with a specially prepared bottom permitting water to permeate the ground gradually to regenerate the urban aquifer. When full the pond became a water environment for children, when frozen it was a skating rink, and when dry, a playground again. He also has proposed sculptures utilizing waves as they break against a concrete wall and are forced into small channels to produce new shapes of spray.

Joseph Kennebrew's Fish Ladder[1] is actually a hatchery situated in an architectural structure of walkways and viewing platforms which integrate sculpture, architecture, ecology and human participation.

John Wilkes explored physical properties of moving water at The Flow Research Group[2] where he experimented with the

[1]Grand Rapids, Michigan, 1974.
2At Emerson College, Forest Row, Sussex England, 1973.

design of vessels, studying how form affected water movement. He discovered that water appears to display a kind of life and intention of its own, with a tendency toward assuming a shperical form, and he has designed Flow-forms which help channel water into rhythmical flowing forms which purify water. He has utilized art, technology and ecological water treatment facilities[1] into water gardens and fountain environments which are recreational and aesthetic, believing that water, part-icularly in urban settings cannot regenerate itself at the speed modern use demands, therefore requires new methods to regenerate it.

Gyorgy Kepes advocates a synthesis of art and technology directed toward urban water management in his recommendations which combine technology and vital aesthetic experiences in ecological environmental fountain art. He foresees water and fountain gardens which function as aeration plants within the central city serving aesthetic and ecological needs as well as serving as a symbolic reminder of our dependence upon water.

Contemporary fountains can be ecological utilizing for example, huge amounts of overheated waste water from industry or water from air conditioning systems, such as Pei's reflecting pool at Boston Christian Science Center, Friedberg's retention basin in Chicago, Piene's Fountain at Lake Constance, Germany (fig. 57), Calder's water garden at General Motors in Michigan. (Pfannschmidt, 1969) My major fountain

[1]Jarna, Sweden, 1973.

environment, WATER WALLS, could utilize these sources of water, since the fountain is designed for recreation areas of computer workplaces. Environmental fountain art can utilize what exists and transform it into a visual and recreational environment.

Huge environmental works like Burgess' (Listening for Light Hinge, 1970) point up ecological process. In this piece 17 ton blocks of ice arrayed in a spiral on the frozen Charles River melt and return to the river which then flows into the sea. We can connect to this image of water transformed into ice, glistening in sunlight, being transformed again by natural process, melting and returning to its source, the sea.

Centerbeam "a sculptural and performance system"[1] (Piene) was a temporary installation consisting in major part of a 144' water prism which presented multiple images (fig. 56) designed by fellows at the Center for Advanced Visual Studies (1977-78). The water prism reflected and refracted light, produced rainbows and provided the central focus for festivities and activities including Earl's laser light and Piene's inflatable sculpture. It was the centerpiece of "bundles of energy" (Burgess, 1980) displaying neon, holographs, steam and laser presentations affected by natural phenomena (weather) and people.

Piene described the event as a "metaphor for the

[1]Otto Piene, Centerbeam, Ed. Otto Piene, Elizabeth Goldring, CAVS, MIT, Cambridge, Mass., 1980.

community of volunteers forming daily symbiosis" and an event inviting "animation because of its supply of energy"[1] as it houses elements: water, air, fire (light) and manifests terrestrial energies. (Piene, 1980).

[1]Otto Piene, Centerbeam, Ed. Otto Piene, Elizabeth Goldring, CAVS, MIT, pg.20, Cambridge, Mass., 1980.

RATIONALE

As noted in the previous section, fountain forms were affected by climactic, socio-political and cultural influences. The same holds true today. However, now science and technology are the dominant influences shaping cities, societies and our world view.

Thus contemporary fountains should relate to contemporary life and images of Greek and Roman mythological creatures do not have relevance to our lives. New knowledge (from science and technology) has influenced our world view shifting toward a more holistic understanding of the universe, ecosystem and process. Since interconnected systems exist within the ecosphere, when one element is disrupted, life is disrupted elsewhere; the ecosphere is like a unified organism. Human beings are also part of this ecosystem affecting and being affected by changes within the system, an idea which has influenced contemporary art, expressed in the new symbolism; interaction and process.

The physical, social and psychological impact of technology is evident in western cities, creating new needs in both city and workplace which have changed significantly and I'll focus on these 2 areas as sites for fountains.

Cities have become more complex, more geared to the machine than to the human being in scale and pace, thereby altering visual and social aspects of urban life. Although there is increasing need to restore a more equitable balance

between nature and the city, actual green areas are dwindling within the city proper. Land originally devoted to parks and playgrounds has been intruded upon by encroaching building and highway development and remaining parks have often deteriorated or are unused.

As a result, of these and other factors many people live in isolation from each other and nature. "Intimate contacts are essential for human survival, yet western industrial societies are the only place people are required to live without them" (Alexander, 1967)[1]. In old cities people gathered at village wells market places where socialization was as important as commerce, (Jacobs, 1961) but today even market places are mechanized and human beings seem to have lost opportunities for spontaneous interaction.

Urban open spaces offer choices for active, passive, individual or collective activity where one may be open to new experiences, substituting positive stimuli to enlarge perspectives (Lynch, 1960). However, underdeveloped urban neighborhoods are often inhabited by families, children and the elderly whose mobility is frequently limited and who tend to be more isolated. Thus, local neighborhood parks can provide accessible places for spontaneous human interaction (fig. 66, 67).

Fountains can provide a focal points and places for

[1]Christopher Alexander, the City as A Mechanism for Sustaining Human Contact in Environment for Marc, Ed., William Ewald, Jr., Indiana, University Press, 1967, pg.67.

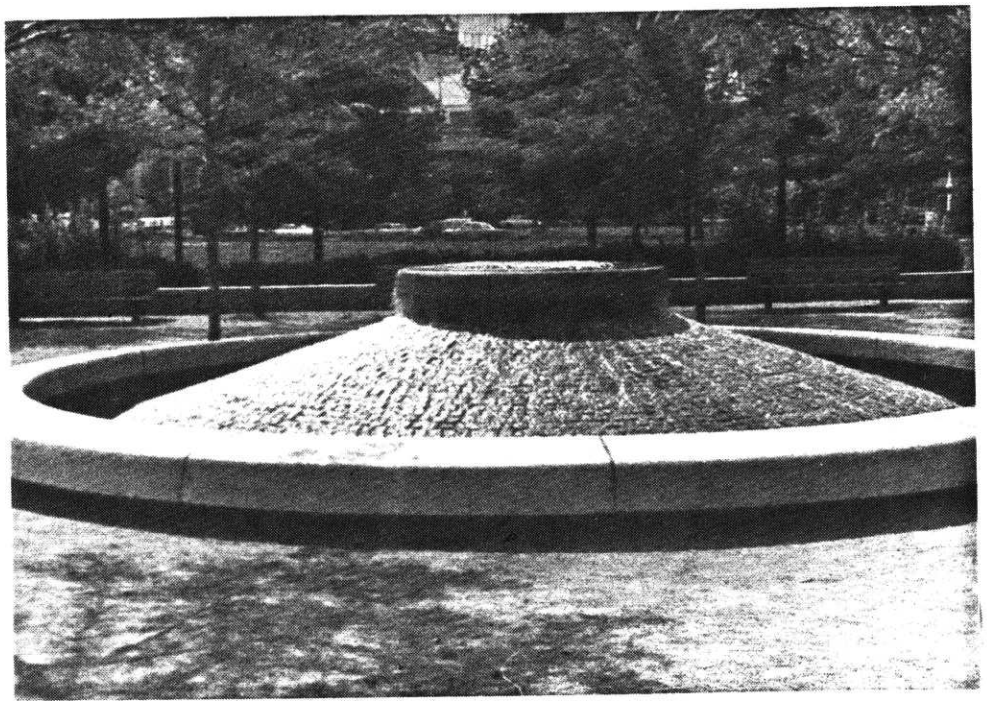


Figure 66

Figure 67

activity or repose. Jacobs (1961) comments that the most successful parks have focal points and offer diverse activities for diverse people. Human beings are drawn to water and have delighted in its sensuous effects for thousands of years. It has historic and symbolic associations, and can provide a source of recreations play and an important educational environment (Lady Allen of Hurtwood, 1984), where children can observe water's qualities and processes. Fountain and water environments offer images of movement relevant to our notions of living things. Multiple possibilities of form and movement; quiet, active, falling, flowing, jetting present diverse visual qualities, inviting different responses from viewer/participants. Wilkes (1979) suggests that water for specific forms may become purification systems, while serving as visual and recreational fountains. His studies on water movement indicate that people perceive life to be expressed in movement and since we expect to see living things move, we can experience a sense of life by watching water's movement. Perhaps fountains in neighborhood parks can help restore a balance between the world of higher technology and nature.

Technology has also changed the nature of the work experience, particularly computer workplaces which allow less human contact and interaction resulting in more de-personalization. As civilization becomes more technological (and trends indicate that the U.S. in particular is becoming more

oriented toward communications industries), these trends will probably continue, creating more international, economic and social problems. (Toffler, 1970). Studies suggest that people working with computers, for example, tend to experience more symptoms of fatigue and stress, which in their most acute states resemble symptoms astronauts experienced in sensory deprivation experiments. Frankenhaueser's study of people working with computers reports the following conclusions:

". . . The risk of serious disturbances of mental functions is particularly pronounced when bodily movement is restricted and social contacts are cut off at the same time as the normal inflow and patterning of sensory stimulation is reduced. However, behavioral efficiency may also be impaired under much less drastic conditions, such as prolonged inactivity of a monotonous work situation. Research on these problems has been stimulated by the realization that technical development is leading to both an increased automation of several kinds of work and to increased demands of attention and efficiency." (Frankenhaeuser, 1972)

John Knesl (1983) writes that "computerized surveillance of performance tends to standardize previously self-managed jobs and increases stress; programmers, word processors and analysts (Murphe, 1983) and that "high demand-low control job design has been shown to be associated with stress and cardio-vascular illness (Karasek, 1982). Visual and special deprivation appear to increase with "back office space" in which lack

of "access to natural light and air" make workers more prone to health hazards (McIntyre 1983). Sensory deprivation leads to non-functioning to the point of actually inducing sleep in extreme situations (Knesl, 1985).

Thus the neighborhood and the computer workplace are two sites with specific new needs where fountains could bring a sense of life and vitality to counteract the effects of de-humanizing environments. It is toward these goals that my fountain designs are directed. It is apparent that the computer workplace presents unique problems for people in contemporary society that have rarely been encountered or recognized previously, although new technology companies now realize the importance of play and social interaction for regeneration and work. With this in mind, I am introducing the use of water environments in recreation areas of the computer workplace in an effort to enhance the aesthetic environment while helping to meet psycho-social need. I am attempting to create humanizing environments which connect people to nature (water) with the understanding that human beings are part of the ecological system, affecting and being affected by their environments.

Water has a profound relationship with human life, visually, physically and symbolically as mentioned inearlier chapters. It is associated with nature, bringing visual qualities and associated meaning; archetypal and personal. Water's optical qualities of refraction and reflection,

capacity for movement, change and transformation (affected by environmental conditions) and its deep symbolic connections to human life render it a perfect material for environmental art. It appeals to all senses, can refresh and restore people and its multiple qualities of movement -- playful, powerful, reflective suggest vitality and life's processes with which people can associate.

People need sensation and fountains that relate to our contemporary world. Laurie (1970) states that we need new pattern and designs with significance for current life, fountains that depict something other than classical myths, in related to contemporary life, our personal feelings or social patterns.

I have designed WATER WALLS specifically for computer workplaces in an effort to provide a richer sensory environment to bringing nature (water) into a non-natural environment to help create a better balance between nature and a high technological environment. WATER WALLS is an interactive experimental 6' working model for a large scale environment or room with water walls and water floor, which one may enter and be surrounded by water. Voice or noise activates sound sensitive lighting, thus it is participatory and interactive. In summary then, the neighborhood and the computer workplace are two sites well frequented on a daily basis, with significant new needs in contemporary society, yet often overlooked as sites for fountains and water environments. WATER WALLS

and other proposed fountains can provide some new forms, with new materials, for new sites with new needs.

FOUNTAIN PROPOSALS

I have created two proposals. The first is a small model of a multiple water sculpture environment which incorporates individual sculptures, utilizing new materials, such as plexiglas, strobes and holograms. The second is my major proposal for "WATER WALLS", a 6' working corner fountain's a model for a water environment of water walls and water floor designed for computer workplaces. Documentation and description of the design process is described in the next section.

The small model consists of the following fountains (fig. 68, 69):

WATER GATES -- water filled tubes of plexiglas or glass arches through which bubbles flow. The progress of moving bubbles creates its own particular sound and is clearly visible through the plexiglas arches, which are not uniform in height or shape. Changing visual images are perceived as one proceeds through his environment, walking under a series of gates suggesting entrances and exits from one place/state to another.

Air flows from an electronically controlled air compressor through a flexible plastic tube to a valve (to prevent water backflow), then to another tube inserted into the water filled tube. A devicecomprised of fused silica glass

beads changes the size of bubbles permitting variation of bubble form and flow. This may also provide a system for re-activating water by injecting air into oxygen deprived water.

WATER ARCHES -- are constructed of three huge plexiglas forms facing each other pouring into a central pool. Before emptying into the basin, water drops onto a round flat surface, like a huge disc, radiating outward toward the rim of the disc, producing bubbles at the edge. The edge is irregular to break up the flow as it drops.

HOLOGRAPHIC FOUNTAIN -- is composed of holographic diffraction grating and a two way mirror. The mirror reflects images appearing simultaneously with forms and patterns inherent in the holographic material.

WATER GARDEN -- is composed of many plexiglas fountains with jets that produce specific flower-like forms, flat at the base which branch out and disintegrate into droplets. These glisten in daylight like lenses and create rainbows when the sun is at a 43^{o} angle. At night water flow appears to reverse direction when a strobe is applied.

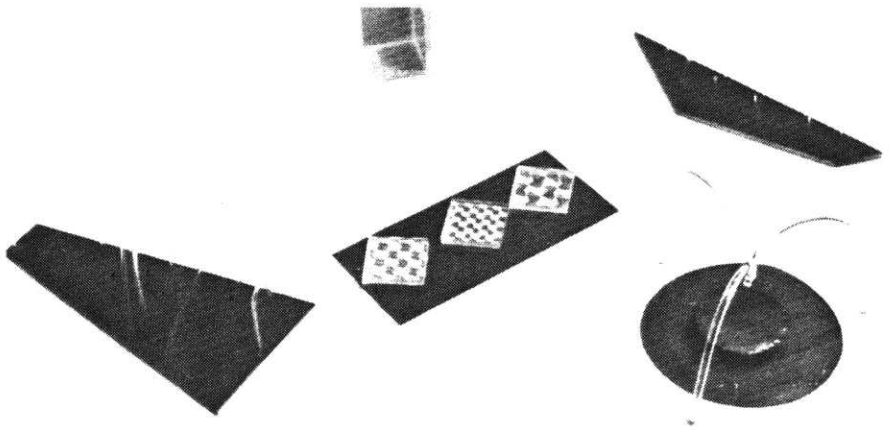


Figure 68

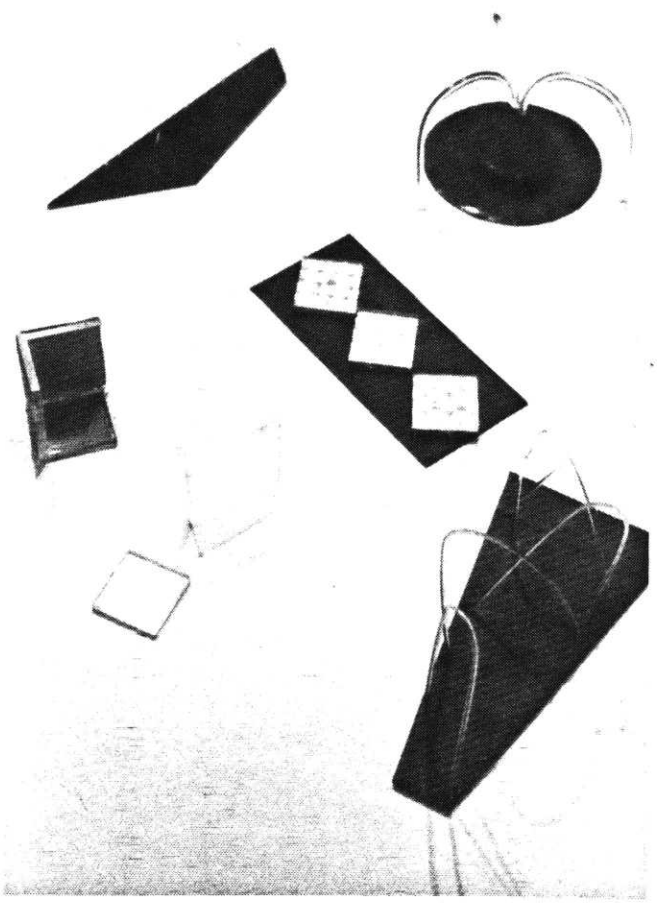


Figure 69

WATER WALLS -- is the major project I will discuss fully in the next section.

All these fountains may also serve ecologic purposes for example, neighborhood and central city fountains may utilize run-off or waster water channelled into pools as a source. Fountains (interior or exterior) in apartment buildings as well as other urban fountain might utilize waste water from air conditioning systems as will channelling that and/or rain water into pools from which small channels could irrigate gardens, thereby returning to the soil, replenishing the local aquifer.

For hygienic reasons water from activity fountains that people play in could all be re-used, channelled into another fountain to feed gardens.

MAJOR PROPOSAL

My major work, WATER WALLS, is an interactive fountain which creates a total environment, a special place which viewer/participants may enter to experience the sight and sound of flowing water, with all its associations and meaning; archetypal and personal. This 6' 8" fountain is designed as a working model for a room sized environment with water flowing through clear plexiglas walls and floor. Although suitable for small neighborhood parks (with some modifications) this particular fountain was designed specifically for recreation areas of computer workplaces. As mentioned in the section, Rationale, studies have indicated that people in computer environments suffer from fatigue and in extreme cases, sensory deprivation. This water environment can provide immediate sensory input through its visual qualities and sound.

This fountain creates a new interactive environment within an existing environment. It is a corner measuring 6' 8" x 2' x 2' with 2 sets of walls set at right angles and a floor set between. Walls are composed of two parts; an inner wall of clear plexiglas, 3" inside an outer wall of black plexiglas. The reason for using black is to prevent visual interference from stimuli outside the fountain. For that same reason the base of the floor is opaque white. Each wall is 3/8" thick with the floor 3/4" to sustain the weight of viewer/participants who enter the fountain. This floor is clear plexiglas, two inches above an inner shelf which rests

above the pool holding more than 10 gallons of water. The shelf is connected to the back wall so water will flow down between the walls across the shelf and down into the reservoir. There is a 2" space between the shelf and the pool's side wall to allow space for falling water.

Water is forced by a recirculating pump (670 gallons per hour) through a 1" clear plexiglas tube behind the outer wall to the top of the sculpture, where it flows through copper tubes imbedded in a plexiglas block. This is connected to 1" diameter spray bars 24" long at the top of both side walls which have a series of 1/8" holes punctured at the bottom to permit streams to flow down between the walls to the shelf below. From there it returns to the lower reservoir, where it flows back into the pump repeating the cycle. It is necessary to use de-ionized or distilled water to prevent discoloration and algae growth.

WATER WALLS is also interactive, since fluorescent lights located atop the piece are activated by voice or noise. These face down to light falling water which sparkles as it flows. Residual droplets also capture and reflect light like small lenses.

This section will describe the process of designing WATER WALLS.

I first experimented with water flow using a small submersible pump moving 200 gal. per hour through a hose with a variety of commercial jets producing square, round and

Figure 70

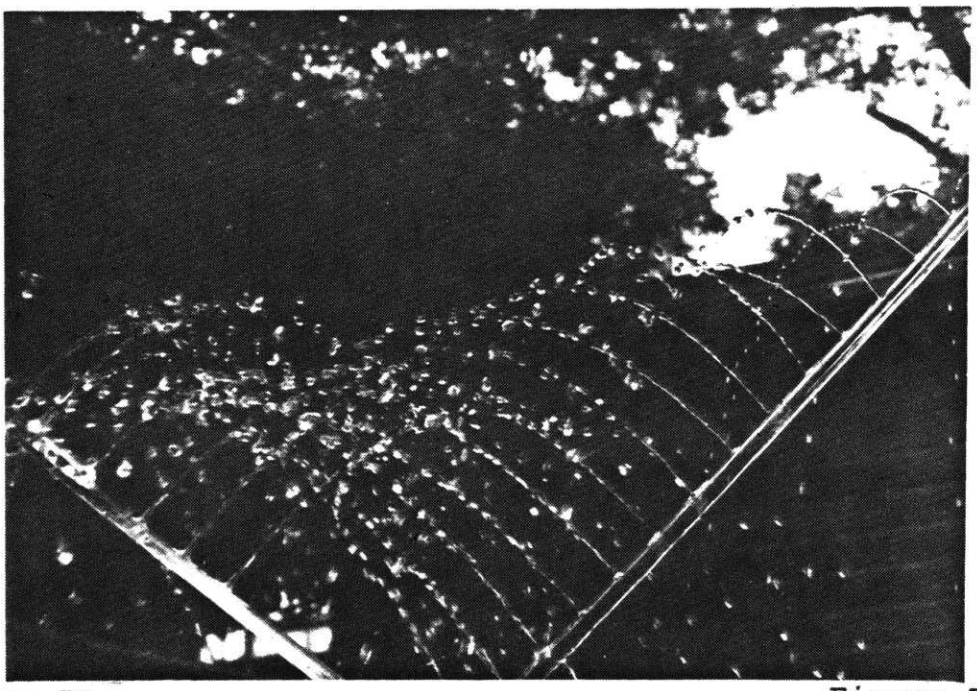
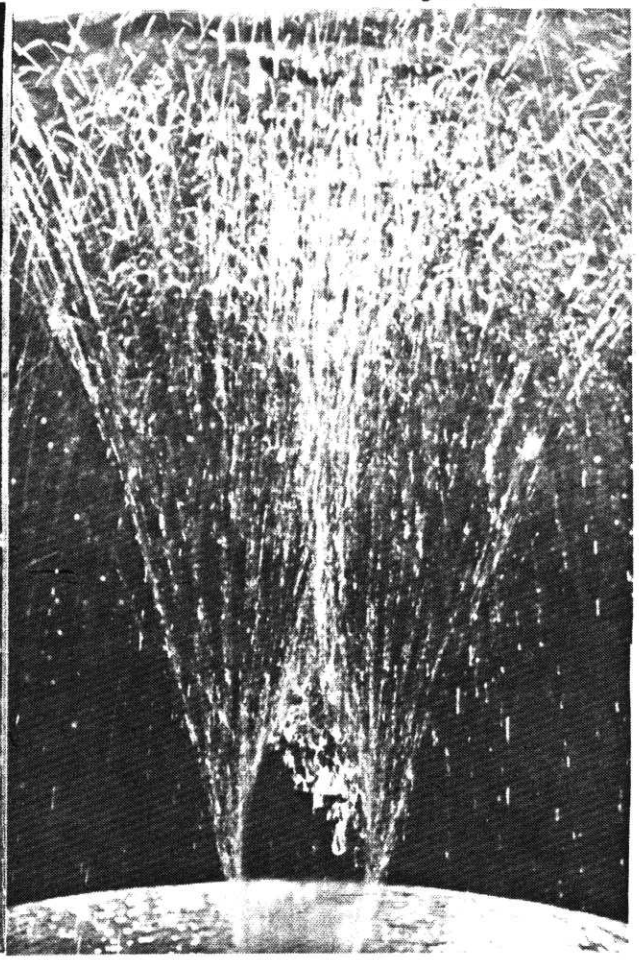


Figure 71

Figure 72



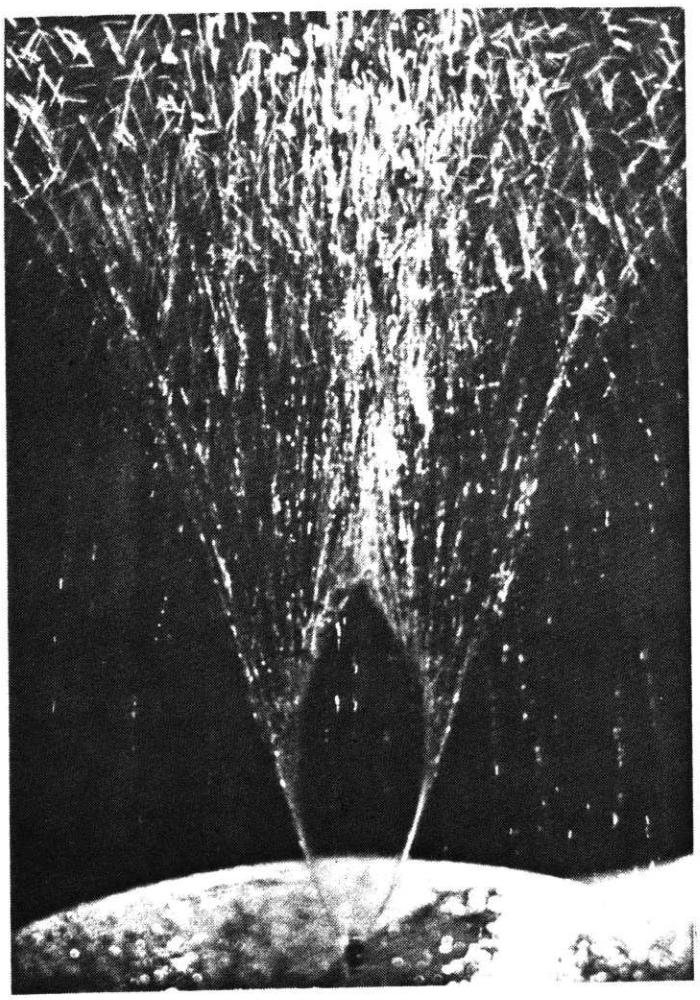


Figure 73

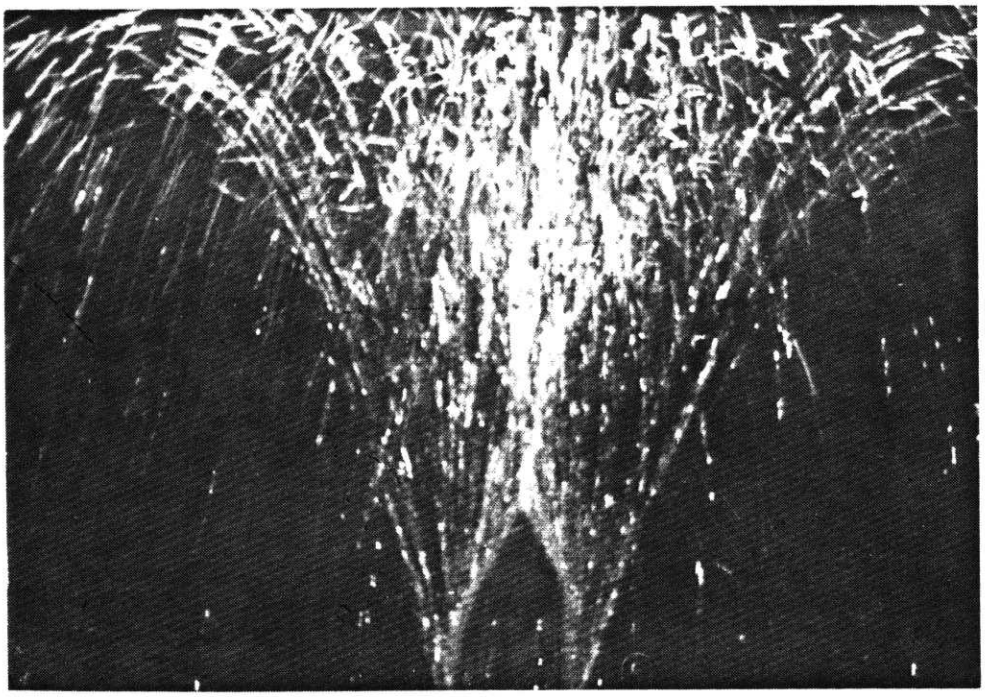


Figure 74

semi-circular sprays. Then I used glass tubes with 1/8 holes 1 1/2" apart; one 24" straight and one curved (fig. 70, 71). When facing each other, these produced new patterns and distinct droplets. Then I used plexiglas tubing with jets, discovering that vee jets produced paper thin, flat oval forms which sprayed outward and fell away in distinct droplets capturing light like small lenses, when illuminated by natural or artificial light (fig. 72, 73, 74). I liked this; both the form and optical qualities and decided to use this particular jet in my fountain. I wanted to create a fountain that one could enter, participate in, affect and be affected by it. I also wanted to design something for contemporary urban spaces with specific new needs -- the neighborhood and the computer workplace -- so I designed a room-like environment with water walls and floor which would surround viewer/participants.

First I made a three foot wooden structure to simulate the corner fountain and experimented with water flow on that model. Then I built a small 1 1/2' plexiglas model, before the large 6' model was constructed. Originally plexiglas tubes with jets ran along the floor spraying upward. It was necessary to use jets producing a flat spray because my design required water to flow between two plexiglas walls. If the spray were round, the pattern would lose form and splash against the panels flowing down like rain against a wind-shield.

When the vee jet was placed between two pieces of glass spaced 4" apart, the pattern and droplets were apparent and did not hit the walls. However, it was not possible for the water to reach a height of more than two feet, so it was necessary to use a more powerful pump sending up 360 gallons per hour. That added power produced a different configuration, causing water to branch out at the top, increasing depth so it splashed against the walls. In order to avoid this phenomenon, the space between the walls had to be widened to 10". However doing that destroyed the illusion of walls. The design was changed, placing spray bars at the top of the fountain so water would flow down between the walls then I could keep the walls relatively thin, separating them by only 3" and send water 6' up via one small 1/2" tube. At the top of the fountain a T joint connected two spray bars, punctured with a series of holes at the bottom. These spray bars were attached to the top of each wall and allowed the water to fall from them like rain. Holes 1/16" diameter increased gradually to 1/8" at the end so water would flow evenly along the bars.

At this point, I was not happy with the quality of water flow, so I used a more powerful pump sending 670 gallons per hour into the fountain. Now, water flowed freely and I could use spray bars with uniform 1/8" holes, with a 5/8" pipe leading from the pump to the spray bars.

The fluorescent light gives the water a slightly blueish cast so that at times the flow and droplets look like ice.

"WATER WALLS" is an experimental model for a large scale environmental piece and as such is open to modifications and amplifications.

In future models, I want to experiment with a variety of water forms and flow activated and transformed by viewer/participants.

This constructed fountain as described has a simple lighting system.

However, for a full scale water wall environment encompassing a room, I would use a more complex user responsive lighting system composed of two systems: one of white light and one of colored light which would be interactive. For the first system, when the viewer entered the sculpture he/she would interrupt a beam triggering a relay and dimmer to increase the existing lighting -- keep it at a higher level for 6 sec. then slowly return to the normal level. I was planning to use 4" submersible fixtures with T-4, 250" watt bulbs with an SCR electronic dimmer system. However because the structure was plexiglas and the light housing bronze, the weight was too great and the wattage too big to have the lights enclosed.

The second system would have a colored lighting system operated by disc activated by the viewer/participant movement into the sculpture, with sensitivity to sound, posture and number of people within the environment. I would also design water flow and form to be variable and user responsive.

WATER WALLS was fabricated by ACRYLIC DESIGNS, Lynn, Massachusetts. I consulted the owner of the company, showed him my drawings and explained in detail how the piece would be constructed. We worked very well together, there were no problems during construction, and the resulting fountain is exactly as I wished it to be.

The fountain was constructed in stages. First, the outer side walls and floor were constructed (fig. 75). Then the spray bars and plumbing lines were created and tested (fig. 76, 77). Afterward, they were connected to the pump. Everything worked as planned. At that point, spray bars were permanently installed with consideration for removal if necessary. The lower shelf was installed on a plexiglas support and tested as was the top piece which would be the floor (fig. 85). They both supported our weight. Then the shelf was installed, the inner walls, and finally the floor. During this process, we tested the pump, for velocity and spray) and the durability of plexiglas under our weight. Ten gallons of distilled water with chlorine is used to prevent discoloration and algae growth. The fountain was transported from the shop to the Center for Advanced Studies, MIT, where it is on exhibition.

Figure 75

Figure 76

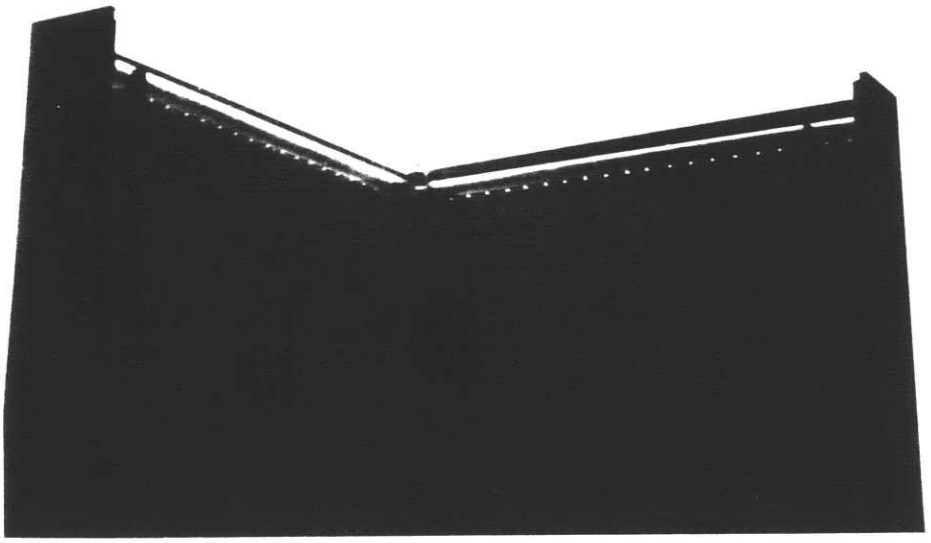


Figure 77

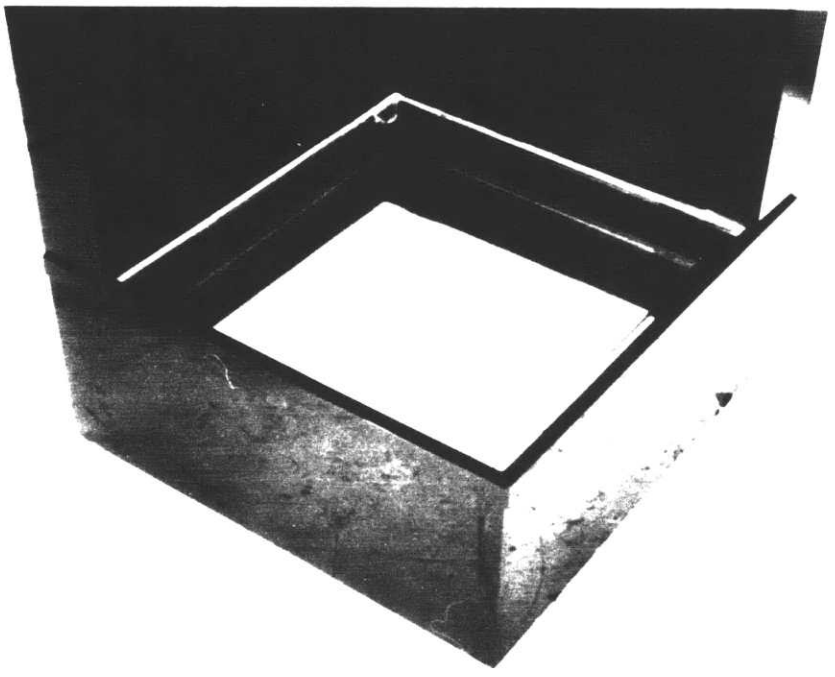


Figure 78

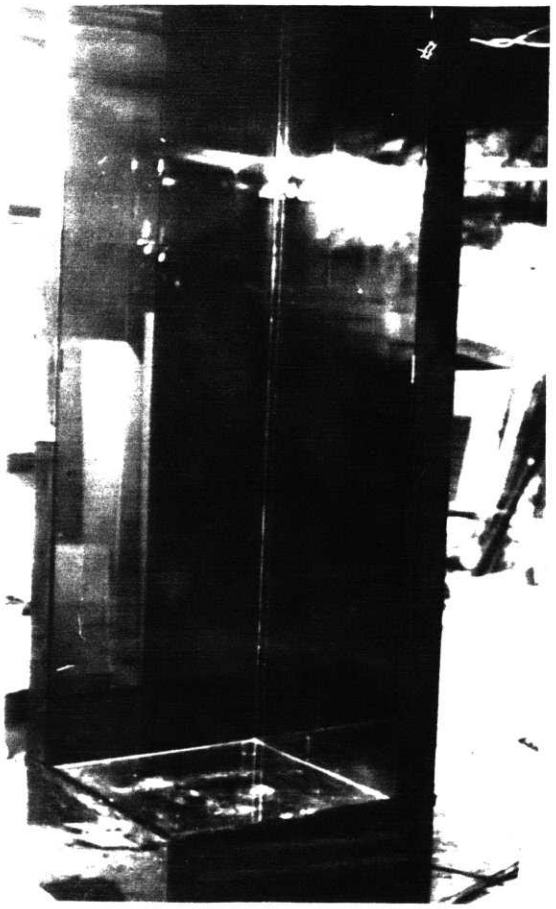


Figure 79

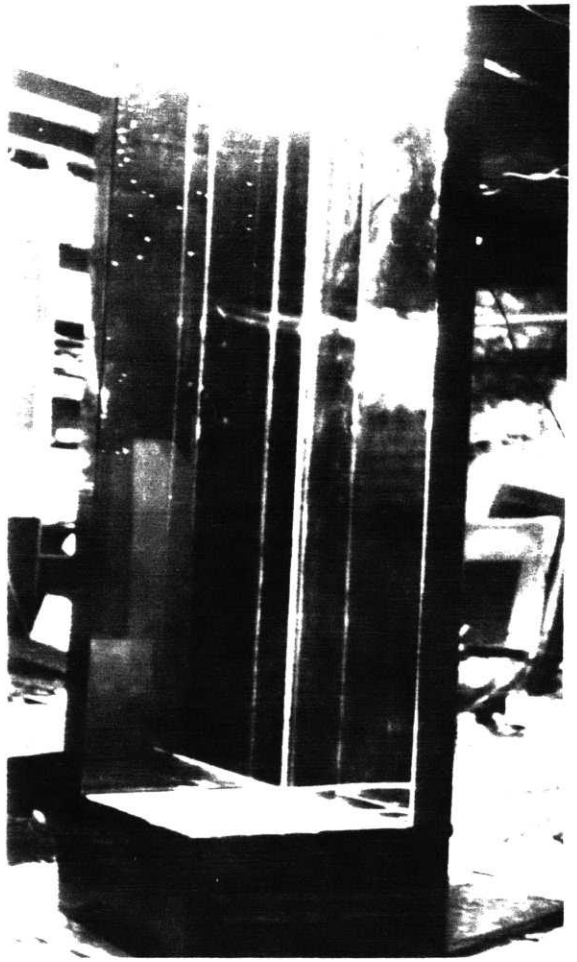


Figure 80

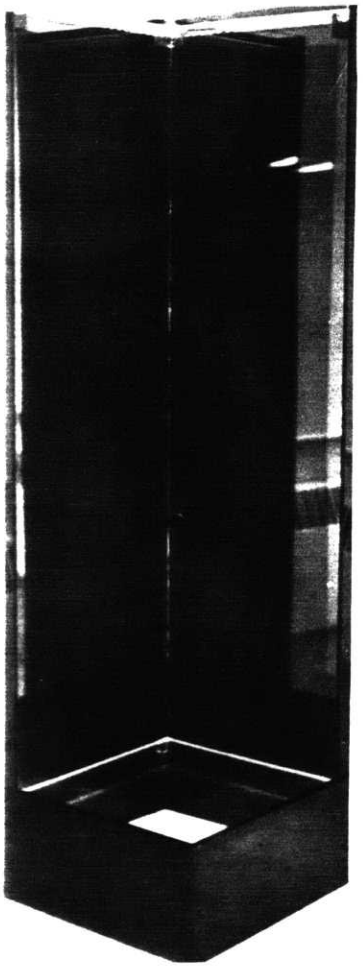


Figure 81

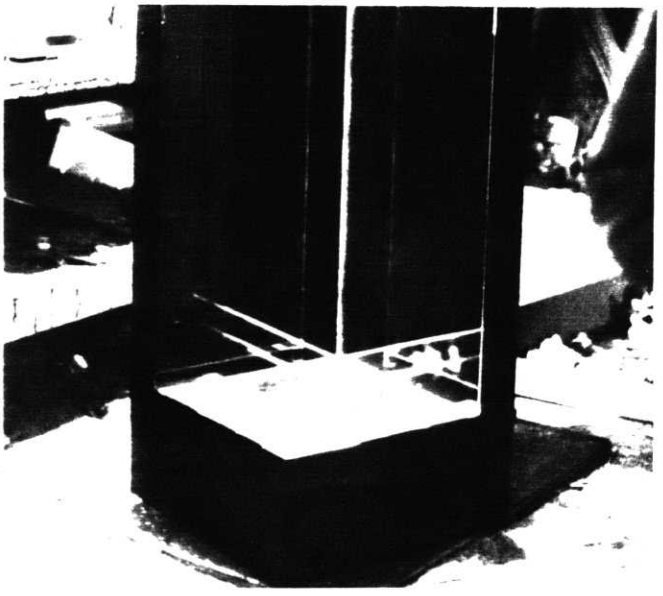


Figure 82

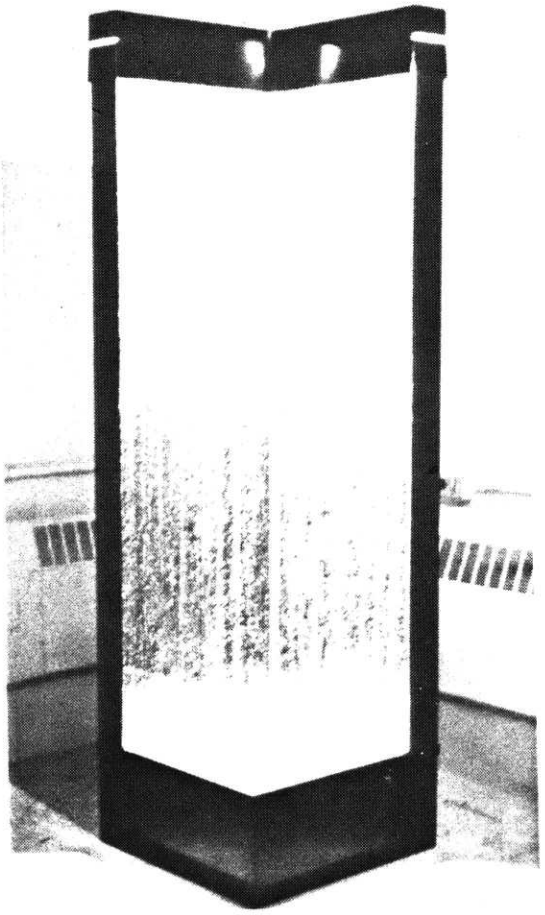


Figure 83

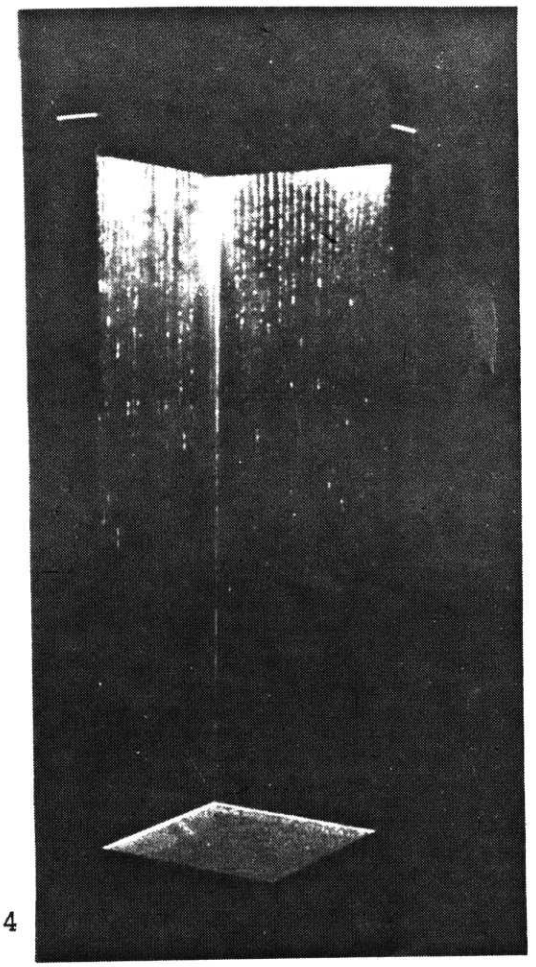
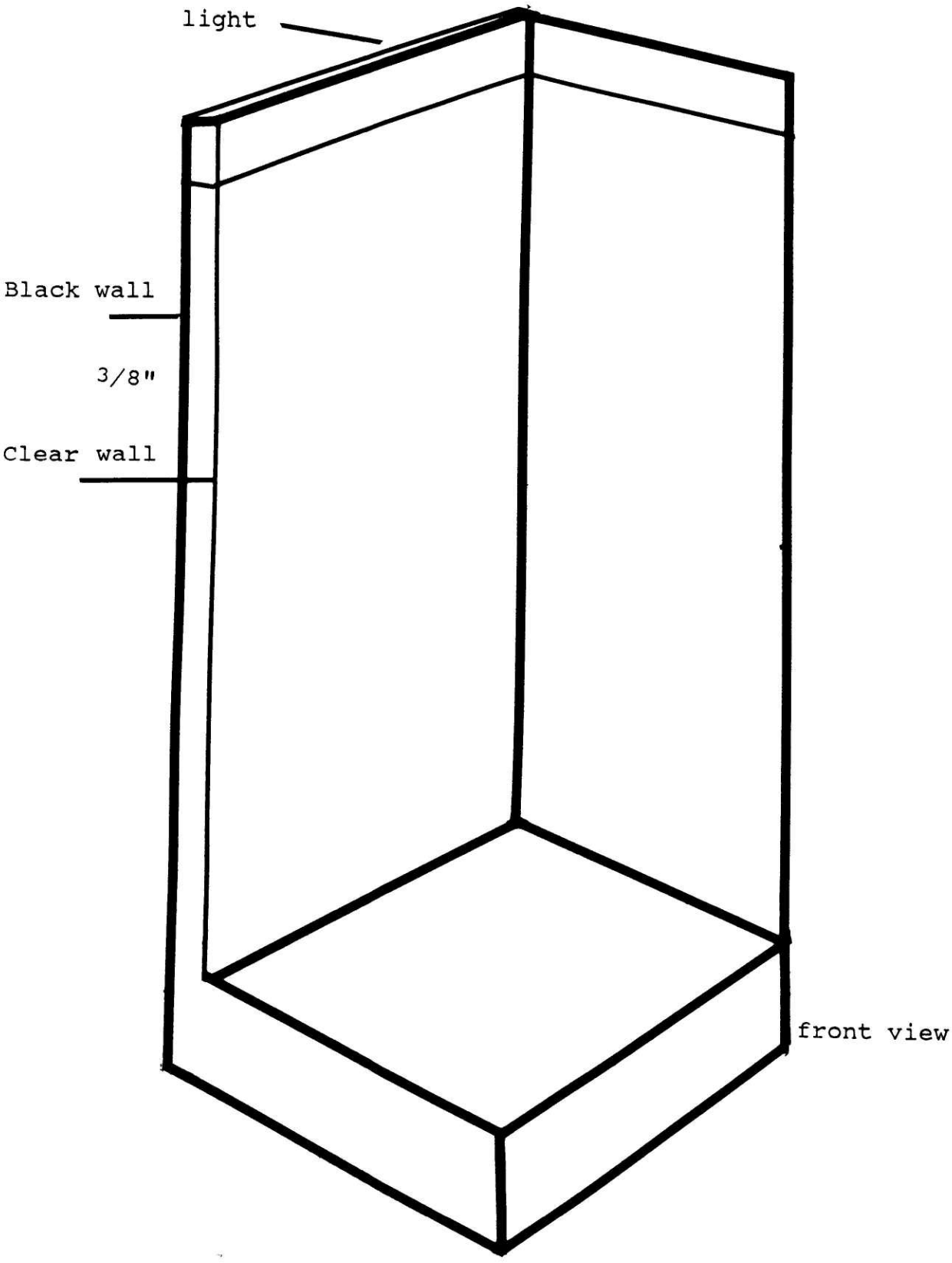
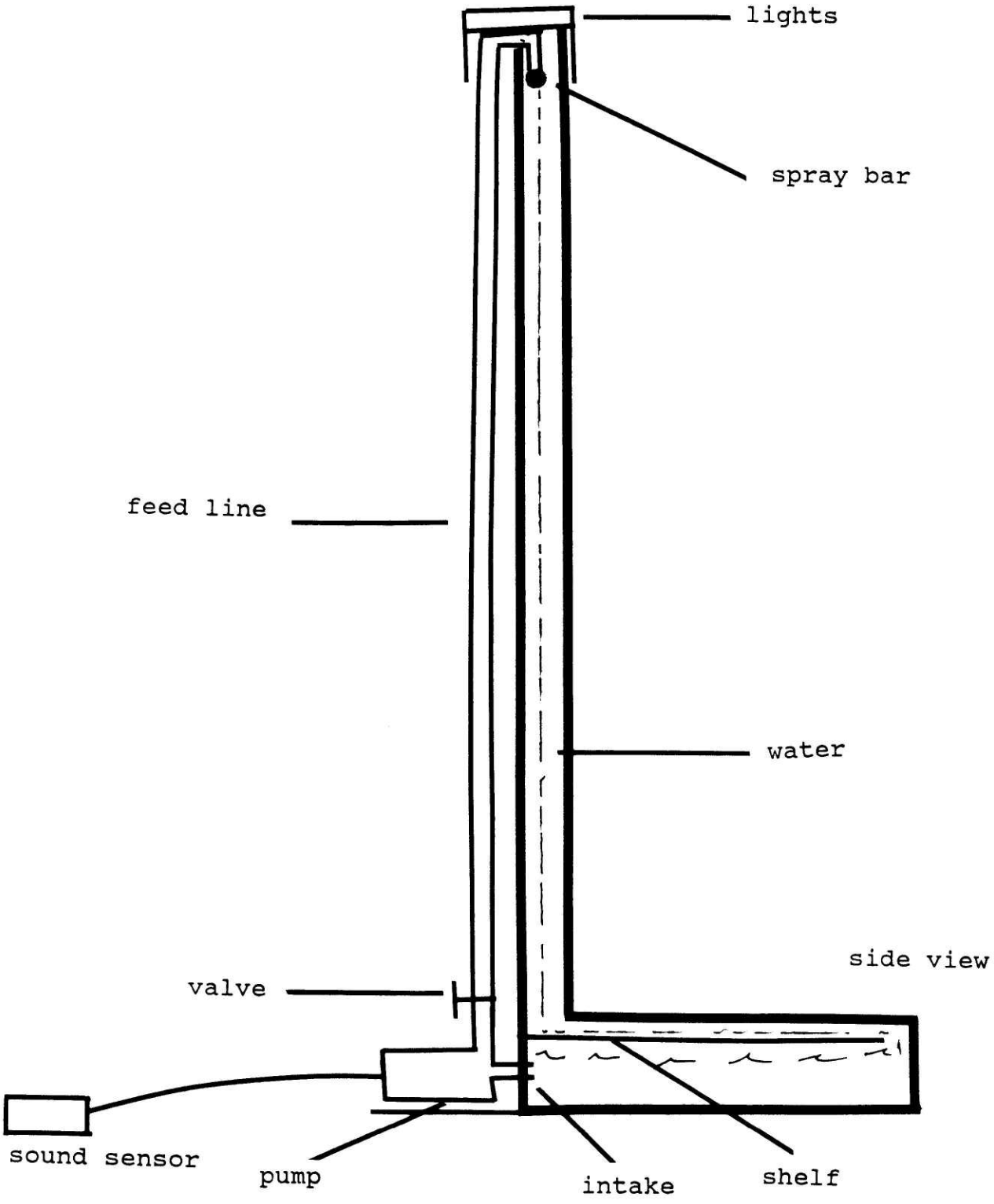


Figure 84


light
Black wall
3/8"
Clear wall
front view


lights
spray bar
feed line
water
side view
valve
sound sensor
pump
intake
shelf

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