A HISTORY OF BUILDINGS' PROBLEM SOLVING

by

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A HISTORY OF BUILDINGS' PROBLEM SOLVING

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THE HISTORY OF BUILDING'S PROBLEM SOLVING

FROM ANCIENT TO MODERN TIMES

In this presentation, I will try to display a short survey of the History of Building's Problem Solving, from the early days of the Ancient Egyptians till today's Computer Age.

The History of Problem Solving was greatly affected by the Industrial Revolution which took place in the 18th C.

Figure 1, provides an overview of the Building's Problem Solving as it relates to some Architectural projects throughout the different ages.

I have divided the History of Building's Problem Solving into two major parts. The EARLIER part, during which technology was MAINLY EMPIRICAL, and the LATER part, during which technology was BASED INCREASINGLY ON SCIENCE. The dividing line is the 18th C. which witnessed this Industrial Revolution.

The EARLIER part before the 18th C. can be divided into two major ages; the Ancient and the Middle ages.

For the Ancient Ages, I will cover only the building's problem solving in the Egyptian, Greek and Roman Architectures.
For the Middle Ages I have selected the Byzantine, Romanesque, Gothic and Renaissance Architectures.

The LATER part, after the Industrial Revolution, can be also divided into three major ages; the EIGHTEENTH century, the NINETEENTH century and the TWENTIETH century respectively.
Fig. 1: Time lines showing division of ages into two main periods, as a result of the Industrial Revolution.
The 18\textsuperscript{th} C. includes the Late Renaissance Architecture. The 19\textsuperscript{th} C. includes the Architectures of some different countries such as: England, France, Holland and the USA.

Regarding the 20\textsuperscript{th} C., I will only display two current ways of Problem Solving in the Design Process. One of them is the Egyptian current Design Method, or the different steps of the Design Process. The other, is the American point of view for stating the Problem according to a particular author.

Throughout the presentation, most of the buildings I selected as examples, were selected for their being typical samples of Architecture in their particular countries, besides their having strong influence and character in their own ages and along different times.

The presentation will raise questions about some selected BUILDING ELEMENTS viz. ENVIRONMENTAL, ARCHITECTURAL and STRUCTURAL FEATURES........... Fig. 2. Answers to those questions will cover the Problem Solving scope of the whole Design Process; namely the FUNCTION, FORM, ECONOMY and TIME.
1. ENVIRONMENTAL ASPECTS:
   1.1. ACOUSTICS.
   1.2. FIRE PROTECTION AND RESISTANCE.
   1.3. HEATING.
   1.4. SUN CONTROL.
   1.5. WATER SUPPLY AND SEWAGE DISPOSAL.

2. ARCHITECTURAL ASPECTS:
   2.1. USE OF GLASS.
   2.2. LIGHTING.
   2.3. VERTICAL TRANSPORTATION.

3. STRUCTURAL ASPECTS:
   3.1. USE OF IRON.
   3.2. THE SPANNING PROBLEM.
   3.3. PREFABRICATION.

FIG. 2: Selected building elements viz.: Environmental, Architectural and Structural aspects.
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Fig. 3: Comparison between Different Ages and Different Building Aspects.

- Implementation on a facility.
- Low interest in solving the problem.
- High interest in solving the problem.
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Fig. 3: Comparison between Different Ages and Different Building Aspects.

- Implementation on a facility.
- Low interest in solving the problem.
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1.1. ACoustics:

Theaters played an important role in the life of ancient Greece, and to a lesser extent: ancient Rome. Both Greek and Roman theaters were arranged in a semicircle...... Fig. 4,5.

Ancient architects noticed that voice not only proceeded horizontally, but also proceeded vertically by regular stages; hence, they perfected the ascending rows of seats in their theaters. They even applied HARMONICS to increase the power of the voice in their theaters and auditoriums.

The Greek and Roman theaters were built in the open air (presumably for fire precautions) which made acoustical problems more difficult when there is no roof to reflect the sound, but their success lies in the use of steeply raked seats.

Acoustics apparently received no attention in the Middle Ages. The Greek and Roman plays disappeared from Europe, and the Medieval plays were performed in the market places, there has been no specially designed theaters in the Middle Ages. However, theater design became a major preoccupation of the Renaissance period especially in Italy.

In the Renaissance period, the theater made a COMEBACK, but with smaller number of audience. Palladio designed a theater, which followed mostly the arrangements of a Roman theater, the seats were steeply banked, but the stage was a semiellipse not a semicircle, and there was no roof.

In the midnineteenth century, the new centers of population created by the Industrial Revolution erected public buildings befitting their new status. Many of the new Town Halls included a large room which could be used as an auditorium. Europe, Australia and the United States acquired a large number of concert halls between 1850 and 1914.
Fig. 4: The Theatre, Epidaurus. Ref. (6).
Fig. 5: A Roman theater according to Vitruvius. Ref. (3).
1.2. FIRE PROTECTION AND RESISTANCE:

Fire has been and still is, a far greater destroyer of buildings than structural failure. Lighting was a major cause of fire, so ancient Greek timber roofs were substituted by stone roofs in the Hellenestic period.

After the great fire of AD. 64, the Emperor Nero cut several wide straight roads through Rome, which acted as firebreaks, and provided quick access for fire fighters. Then, they looked forward to having a well-organised fire brigades and engines that could project water under pressure. Besides, the Romans limited the heights of buildings to 70 ft. They prohibited party walls between houses, and each new house had to have its own separate wall.

Fig. 6, shows a mechanism for spontaneously opening the doors of a temple when a fire was lit on the Altar.

Yet, fire fighting in the middle ages, relied mainly on chains of people passing buckets of water.

The cross-vaulted roofs of the Gothic Cathedrals required a pitched timber roof to protect them from the rain. In turn, the masonry walls prevented the spread of fire from the timber roof. Thus the double roof structure which at first sight seems wasteful, had an essential protective function.

In London, the great fire of 1666 led to the creation of the first modern fire brigades. Later on, in the 18th C, many European and American cities created full-time fire brigades which were mostly operated by the government.

Fire resistance was the main reason for switching from the use of the more versatile timber structures, to the use of the more fire resisting masonry materials. It was also a principal reason for the use of cast iron as the structural material for factories in the 19th C.

However, when steel was substituted for cast iron in the late 19th C., additional fire proofing was required, because steel deflects dangerously at temperatures above 840°F, which are easily attained in large fires.
Fig. 6: A mechanism for opening the doors of the temple when a fire was lit on the altar. Ref. (3).
1.3. HEATING:

Improvement of a cold environment by heating is as old as the use of fire by primitive man. Fire places have been found in houses in Troy, dating from about 2000 BC., and in other contemporary settlements. An open fire was lit in the center of the room, and the smoke escaped through a hole in the roof. This method was still used in some of the Royal Palaces of England in the 15th C. AD.

The Greek and the Romans used charcoal braziers for heating, and these were often elaborately decorated objects of bronze. In the colder climates of Germany and the Netherlands, large braziers became in the 16th C. fully enclosed metal stoves. In Easter Europe, large ceramic stoves became a part of the interior decoration.

However, the most advanced heating system prior to the 19th C. was the Roman Hypocaust, which originated in the 1st C. BC. ................. Fig. 7. The Hypocaust was formed by passages under the floor. Hot gases from a furnace at one end passed to a chimney at the other end, these heated the floor surface. These passages were about 6 in. wide, and formed by brick piers about 18 in. square by 24 in. high. On top of those piers were placed thin square bricks. The floor on top of these bricks was generally of concrete paved with mosaic. Hypocausts were first used for hot rooms in the public Roman Baths, but later they were used in villas of wealthy Romans too. Modern methods of heating date from the Industrial Revolution. In 1784, James Watt, the inventor of the condensing steam engine, used waste steam from his plant to heat his own office, and later the entire factory. It was in the first decade of the 18th C. when both Watt and William strut used waste steam for heating factories.

Heating improved rapidly from the end of the 18th C. Tile stoves, which made an appearance in Germany and Scandinavia during the 17th C., flourished during the 19th C. in central and eastern Europe.

In Britain the open fire place was preferred during the 19th and the first half of the 20th C. ............................. Fig. 8.

In North America, were the climate was more severe, domestic heating was generally supplied by a boiler, or hot-water or steam radiators.
Fig. 7: Sketch of the Hypocaust heating beneath a mosaic floor in Rome. The furnace entrance is on the left, and the chimney on the middle top. The smoke passed between the brick pillars to heat the floor. Ref. (3).
Fig. 8: Collection of chimney flues into a central stack, in a 19th C. house. Ref. (4).
1.4. SUN CONTROL:

Sun shades have been used in many parts of the world. In Muslim Architecture roof overhangs shading the windows were a common feature. In hot-arid climates like Egypt, a pool of water or a fountain was often added. Its evaporation lowered the temperature, and increased the humidity. Besides, there were some devices like the MASHRABIYA for filtering and controlling the amount of light entering into the space. Houses were also designed introvert, and rooms were gathered around an internal semi-shaded court.

The veranda was developed in India, then it was introduced into several British colonies............................. Fig. 9

In the southern USA, the Greek revival style achieved great popularity during the 19th C., at least partly because the roof overhang supported on columns provided sunshading................................. Fig. 10

In some parts of North America, summer is hot, and the roofhangs have been used by many American Architects. Most of the "Prairie" houses built by Frank Lloyd Wright in and around Chicago, between 1889 and 1910, had carefully designed roof hangs.
Fig. 9: Veranda in a 19th C. house with cast iron columns and railings. Ref. (2).
Fig. 10: A classical colonnade shading the windows of a Nineteenth Century house in New Orleans, USA. Ref. (4).
1.5. WATER SUPPLY AND SEWAGE DISPOSAL:

Piped water supplies and sanitary installations have been found in the ruins of several early civilisations which dates from about 2,000 years BC. The Romans created a water supply system which served the entire population not only the ruling families as previous civilisations did.

The first of the 11 aqueducts of ancient Rome was built in 312 BC, and the last in 226 AD. By that time the system had a total length of 560 Km (350 miles) and most of it was underground. Since the Romans did not use pressure pipes, the water channels had to cross valleys on embankments or arched aqueducts.

The Romans did not purify water, but they kept the water from the various aqueducts in separate channels, and protected it from pollution... See Figs. 11, 12. The cleanest water was used for drinking, and the least satisfactory for sewage disposal.

The aqueducts of Rome were maintained in good condition until the 5th C. Then they were gradually destroyed until the water supply failed completely in the 11th C. In the 17th C. 3 of the aqueducts were restored; these still form part of the water supply of modern Rome.

Sewage disposal existed on a small scale before Roman times; sometimes by building toilets over running brooks, and sometimes by using jugs of water. But during the Roman Empire, toilets with running water were supplied for most of the population. And the main sewage of Rome was discharged through the CLOACA MAXIMA in the river TIBER.

Medieval standards of hygiene fell far below those of Ancient Rome. In London the River Thames and wells provided the only water supply until the 13th C. when the first pipe was laid. It was not until 1871, when the London Main Drainage Scheme provided London with a proper sewerage system. A year later, Brooklyn instituted another sewerage system. Sand filters had been used since the 1830s. However, results were not entirely satisfactory, except in places in which clean water came from a distant clean source carried to the city by an aqueduct.
Fig. 11: Reconstruction of the crossing of five Roman Aqueducts, at the Via Latina. The water from the different aqueducts was not allowed to mix. Ref. (2).


Fig. 12: The Aqueducts of Rome. Ref. (6).
2.1. THE USE OF GLASS:

In ancient times, glass was little used as a building material. Even Vitruvius who described every single material in detail, did not mention it. A few window panes have been found in the buried city of Pompeii, but glazed windows were rare in ancient Rome.

Windows became more common during the middle ages. The best known examples are the stained glass windows of the Gothic Cathedrals, painted since the 12th C. From the 14th C. onwards, glass windows were frequently used in palaces and in the 16th C. they became common in middle-class houses.

Some Medieval and Renaissance buildings have very large windows; few modern public buildings have continuous glazed surfaces comparable in size to the west window of a Gothic Cathedral.

Green houses and orangeries were a feature of the 19th C. These were garden houses with large windows facing south. Fig. 13. The Crystal Palace designed by Joseph Paxton in 1850 was in fact a large green house. Fig. 14. In turn it provided the prototype for the later glass-walled exhibition buildings, such as the "Galerie des Machines" erected in 1889, and for the newly established department stores which depended mainly on glass-roofed internal light wells, as did the 19th C. shopping arcades.

Complete glass walls were first constructed in the second half of the 19th C. An early example is the glass wall separating the stack from the reading room in Henry Labrouste's "Bibliotheque Nationale de Paris" in 1858-1868. Fig. 15.

Examples of using glass in roofing large span halls, libraries, museums and shopping arcades. Figs. 16, 17, 18, 19.
Fig. 13: The use of glass in English Buildings. Ref. (6).

B. Revised structure, erected (1852-4) at Sydenham, London.

Fig. 14: The Crystal Palace, in London, designed by Joseph Paxton. Ref. (6).
Fig. 15: The glass wall between the stacks and the reading room in the National Library in Paris, 1858-68. Ref. (7).
Fig. 16: The glass and metal roof of The Stock Exchange, in Amsterdam, 1898-1903. Ref. (6).
Fig. 17: The use of Glass and Cast Iron in the Gantt Building, 219-221 chestnut street, St. Louis river front, 1877. Ref. (7).
Fig. 18: The use of glass and iron in the University Museum, Oxford, 1855-9. Ref. (6).
Fig. 19: The use of glass and iron in The Providence Arcade, in Providence, Rhode Island, 1828-29. Ref. (8).
2.2. NATURAL AND ARTIFICIAL LIGHT:

Perhaps one of the most obvious features of natural lighting in ancient architectures, is the "Clearstory", which was first introduced in the ancient Egyptian Architecture as some vertical perforated stone slabs in the roofs of the Temples. Fig. 20

One of the most daring features regarding this matter is found in the Ramasium Temple, where there is this Clearstory in the roof, that permits direct light to enter into the interior of the Temple only two times a year, to light the faces of the statues of Ramsis; the first time is the date when Ramsis was born, the second is the date when he was crowned King.

In Greek Architecture, the tall Athena Statue standing in the great interior room of the Parthenon was softly illuminated by 3 kinds of light. Direct light came from the large open doorway. Indirect light was reflected off the shallow pool at the foot of the statue up into Athena's face. Finally, a diffused light came through the translucent marble tiles of the roof. Fig. 21

In Haja Sophia, Istanbul, the 6th C., we find the culmination and perfection of a thousand years of experimentation with light. Fig. 22

The great dome and its attendant semidomes have a series of equal windows ringing their bases, that seem to detach the domes from their earthly supports.

During the Gothic Era, Church windows increased greatly in size, this is most probably because the most of the Gothic Churches were built in the temperate zone where large windows have always been welcome.

However, the size of windows is not purely determined by the amount of daylight required. During the Middle Ages when SECURITY was a problem, even within the city walls, windows tended to be smaller and narrower, except in Churches or Cathedrals, which were regarded as sanctuaries.

Windows in the Italian Renaissance Palaces were notably smaller, to limit the admission of undesirable heat; but when the Renaissance was adopted in England, the windows in the classical facades tended to become much larger. Fig. 23
A. Great Temple of Ammon, Karnak: Hypostyle hall (restored model) (c. 1312–1301 B.C.).

B. Great Temple of Ammon, Karnak: view across Hypostyle Hall.

Fig. 20: The use of the Clearstory in the Egyptian Architecture. Ref. (6).
Fig. 21: The interior of the Parthenon, Athens, in the fifth century B.C., with the gold and ivory statue of Athena. Ref. (5).
Fig. 22: Haja Sophia, Istanbul, in the sixth century. Ref. (5).
Fig. 23: Windows in the Palazzo Farnese (left), in Rome, and in Lindsey house (right), in London, built about 1640. Ref. (2).
2.3. VERTICAL TRANSPORTATION:

Mechanical lifting devices have been used in underground mines, at least since Ancient Roman times.

In the late 18th C. mechanical power produced by water-wheels or steam engines was introduced for hoisting the mining cages, but fatal accidents continued to occur when the cage dropped through failure of the hoisting rope or the mechanical brake.

The invention of Graves Otis consisted of a safety device which prevented the platform from falling. In 1854 he demonstrated this in public at the Crystal Palace Exhibition in New York. He had himself hoisted above the ground and ordered the rope to be cut. As the platform came to a stop, he made his historical remark: "All safe, gentlemen." .... Fig. 24.

This safety lift was adopted immediately in the USA for lifting goods, but its acceptance for passenger transport was initially slow. However, by 1871, more than 2,000 lifts were in service in America, and the major buildings erected in Chicago after the great fire of 1871 had lifts.

The limiting factor for the height of buildings was not the strength of the structure, but the amount of stair-climbing which people were prepared to accept. The lifts raised the limitation and the Chicago buildings grew in height.

By 1882, buildings reached 10 storeys, and the "Skyscraper" was born. In 1892, buildings reached 21 storeys.

On the other hand, Gustave Eiffel in his 1000 ft. tower, designed for the Paris Exhibition of 1889, elevators ran in the interior of the supports as far as the second platform. Another elevator ran within the core of the structure from the second to the third platform, rising 904 ft. above the ground.
Fig. 24: Public demonstration of the safety lift by Otis at the Crystal Palace Exhibition in New York in 1854, Ref. (2).
3.1. THE USE OF IRON:

It was found that the Greeks used iron under the architraves of the Temple of Zeus in Sicily. It may however have served primarily as a construction aid or permanent formwork.

The Romans through experience have seen that some stone or brick arches failed under pressure, so they used metal clamps, usually of iron, and sometimes of bronze. In some cases, it was found that every stone was fixed by two metal clamps to the two stones next to it, which in a way had an effect almost like that of reinforcement in modern concrete.

Even during the Renaissance period, and especially in the dome of St. Pietro in Rome, which is a brick dome covered with lead, iron clamps were used to join the masonry blocks with each other.

Later on, the effect of the Industrial Revolution on Architecture was tremendous. In the first place, it introduced the Iron Frame.

If we compared the difference between the best Architectures of the 2nd century AD., the 18th C. and the 20th C., we would find far less difference between the first two, than the last.

Examples of using Iron in different buildings............ Figs. 25,26,27,28.
Fig. 25: Reinforcement in the masonry of St. Genevieve, Paris, about 1770. Ref. (3).
Fig. 26: Vaulting of large spaces by iron and masonry, a design suggested by Viollet-Le-Duc in the middle of the 19th C. Ref. (3).
Fig. 27: The use of Iron in The International Exhibition, Paris, 1889, Galerie des Machines. Span, 115 meters (377 feet). The first time a span of such size had ever been bridged. Ref. (7).
Fig. 28: The use of Iron in The National Library, Paris, (1862-8). Ref. (6).
3.2. THE SPANNING PROBLEM:

Admiration for big objects is an ancient condition. The seven wonders of the world were all remarkable not only for their beauty, but also for their great size, and this fascination has continued to modern times.

In AD. 123, the Romans built the Pantheon with a span of 143 ft. This record was held for almost 1700 years. During the 19th C. this span was more than doubled by the use of structural steel. The "Galerie des Machines" built in 1889, had a span of 377 ft.

The Spanning Problem remained a main preoccupation of Architects from the days of ancient Rome to the early years of the present century. Actually, it is not known for sure, whether this absence of large spans was due to the warm climate which made outdoor living feasible, or, was it to the lack of durable materials which could last for long periods of time.

Most probably, reeds and timber were more plentiful in the ancient world, and presumably were used extensively, and, unlike masonry, timber has good tensile strength and it can span farther than stone beams. However, timber and reeds are less durable than stones and they were greatly affected by fires.

The deficient tensile strength of masonry is responsible for the limitations in span of all permanent structures before the 18th C. and it has largely determined their structural form.

Along the ages, different structural forms, with different building materials were introduced to cover big spans, like Vaults, Shells, Domes, Parabolas, and Frames.......................................................... Figs. 29,30,31

Later on, besides timber, stone and concrete, Iron was the reason for such daring structures like the long span bridges and the Galerie des Machines in Paris.
Fig. 29: The arch and its three-dimensional extension into vault forms. Ref. (8).
Fig. 30: Diagrams for Medieval vaulting. Ref. (8).
Fig. 31: Diagrams for the placing of a dome on a square plan. Ref. (8).
3.3 PREFABRICATION:

Timber houses have been prefabricated in England in panels, at least since the 17th C., when they were taken from there and shipped to North America. In the 18th C., similar panels were made on the American East Coast for shipping to the West Indies.

Prefabication in England was well established, and since 1830, a number of British factories had specialized in the production of cast iron and wrought iron prefabricated houses for export.

In 1894, the second year of the gold rush, prefabricated houses of timber and iron arrived to California, not only from England and the American East Coast, but also from Australia and New Zealand.

The Crystal Palace, designed by Joseph Paxton, was the first large prefabricated building. It was prefabricated in six months, and was erected in Hyde Park, London, in another six months in 1850-1851. All connections and all window panes were standardized. It was only by this high degree of standardization that the building could have been built in such a short time according to its program statement...................... Figs. 32,33

After the Crystal Palace of London, many other iron and glass palaces were built subsequently, the most notable were the Crystal Palace of New York in 1853, and the Crystal Palace of Chicago in the year 1873.

In the second half of the 19th C., standardisation and mass production were applied to a wide range and variety of manufactures. The movement started in the USA where the labour was scarce and expensive, but it soon spread to Europe.

The first attempt to mass produce houses, was made after World War I, and a total of 88 building systems were approved employing timber, steel, ceramic blocks and precast concrete.
Fig. 32: Bolting the cast iron girders to the cast iron columns of the Crystal Palace, in London. Ref. (4).
Fig. 33: Raising the cast iron girders in the central aisle by horsepower, in the Crystal Palace, London, 1850. Ref. (4).
After World War II, the new building systems utilized aluminium in addition to the materials previously employed.

Later on, the timber and metal houses proved unpopular, and precast concrete emerged as the most successful material for system building, particularly for multi-storey construction.

In the USA, unsuccessful attempts were made to introduce system building in the European manner. However, the Mobile Home, was a uniquely American solution to the same problem.
DEFINITION:

DESIGN METHODOLOGY
IN EGYPTIAN PRACTICE

Design methodology, is the study of the PRINCIPLES, PRACTICES AND PROCEDURES of design in a rather broad and general sense........THE 3 PR'S........

Its central concern is with HOW DESIGNING IS and MIGHT BE conducted. This concern therefore includes the study of how designers work and think the establishment of appropriate structures for the design process; the development and application of new design methods, techniques & procedures; and reflection on the nature and extent of design knowledge and its application to design problems.

The development of this new field of design methodology has been conducted principally through means such as conferences and the publication of research papers.

The acronym is ............BASDAC

B= Briefing, Programming and Data Collection.
   This is done through fulfilling the 5 steps of programming which are: 1. Establishing GOALS, 2. Collecting and analysing FACTS, 3. Uncover & test CONCEPTS, 4. Determining the NEEDS, 5. And finally stating the PROBLEM.

A= Analysis.
   Comparative analysis for similar projects.

S= Synthesis, (Developing Concepts).
   Creating a Concept.
   Sometimes creating more than one concept (having alternatives).

D= Design or Development.
   Developing the concept or alternatives, to produce complete preliminary project with Plans, Sections, Elevations and Perspectives... This process is an integration between the two steps Analysis and Synthesis.

A= Appraisal (Optimization) or Evaluation.
   Comparing the different alternatives in the Design or Development step and picking the most suitable design. Feasibility studies could assist in this appraisal step.
C=Communication.

The last step in the design process is the Communication between the designer and the client.
It concerns the presentation of the whole project's drawings to the client. This includes:
Full drawings, reports, colored slides, video films and any other convenient way of presentation.

Figure 34, shows the Egyptian current Design Method, or the different steps of the Design Process.

Figures 35 and 36 show the American point of view for stating the Problem according to a particular author.
FIG. (34): STEPS FOR THE DESIGN PROCESS IN EGYPTIAN PRACTICE.
THE 5 STEPS OF PROGRAMMING

1. ESTABLISH GOALS
2. COLLECT AND ANALYZE FACTS
3. UNCOVER AND TEST CONCEPTS
4. DETERMINE NEEDS
5. STATE THE PROBLEM

1. WHAT & WHY
   WHAT DOES THE CLIENT WANT TO ACHIEVE & WHY?
2. WHAT IS IT ALL ABOUT
3. HOW TO
   HOW DOES THE CLIENT WANT TO ACHIEVE THE GOAL?
4. HOW MUCH
   MONEY, SPACE & QUALITY?
5. WHAT SHOULD BE DONE
   WHAT ARE THE SIGNIFICANT CONDITIONS AND THE GENERAL DIRECTIONS THE DESIGN OF THE BUILDING SHOULD TAKE?

Fig. 35: Personal interpretation of the American Problem Solving, after Pena, Parshall and Kelly, authors of Ref. (9).
THE 4 CONSIDERATIONS OF THE PROBLEM

1. FUNCTION
   1. PEOPLE.
   2. ACTIVITIES.
   3. RELATIONSHIPS.

2. FORM
   1. SITE.
   2. ENVIRONMENT.
   3. QUALITY.

3. ECONOMY
   1. INITIAL BUDGET.
   2. OPERATING COSTS.
   3. LIFE-CYCLE COSTS.

4. TIME
   1. PAST.
   2. PRESENT.
   3. FUTURE.

THOSE FOUR CONSIDERATIONS OF THE PROBLEM COVER:

FUNCTION 1. THE FUNCTIONAL PROGRAM.
FORM 2. THE SITE.
ECONOMY 3. THE BUDGET.
TIME 4. THE IMPLICATIONS OF TIME.

Fig. 36: The four considerations of the Problem, according to authors of Ref. (9).
SUMMARY AND CONCLUSION:

The ancient world, like the modern, was greatly affected by sheer size. The Seven Wonders of the World, listed by Greek and Roman authors, were:

1. The Pyramids of Egypt.
2. The Hanging Gardens of Babylon.
3. The Temple of Diana in Asia Minor.
4. The statue of Zeus at Olympia.
5. The Tomb of King Mausolos in Asia Minor.
6. The Kolossos Statue at the entrance of the harbor in Rhodes.
7. The Lighthouse or the Phanara of Alexandria in Egypt.

These wonders were remarkable mainly for the mass of material employed. The monuments that survive from Ancient Ages frequently consist of piles of stones, like the Egyptian Pyramids, or piles of mudbrick like the Ziggurats of Mesopotamia.

Actually, no big emphasis was given to Environmental Aspects in the Ancient Ages, until the Greeks and the Romans found interest in environmental aspects such as: Acoustics, Fire protection and Resistance, Heating, Sun Control, Water Supply and Sewage Disposal.

The Romans were the first to build public baths, water supply and sewage disposal systems for the entire population. They were also the first to build great interior spans. But this does not mean that other civilizations were not able to solve the spanning problem. The fact that there are no big span buildings existing from those civilizations might be due to the indurability of the building material which most probably was wood or timber. Besides, the warm climate in which those civilizations developed, might have made outdoor living feasible.

The Greeks and the Romans were also the first to use Iron in their structures. And the Spanning Problem did not become a main preoccupation of Architects until the days of Ancient Rome.

However, Egyptian, Greek and Roman architectures showed great interest in natural lighting. They introduced so impressive solutions for the Lighting Problem.
During the MIDDLE AGES, emphasis were given to the Structural and Architectural aspects of the building rather than the Environmental aspects. It can be noticed that the Spanning Problem, together with the use of Glass and Natural Lighting, were the main preoccupation of Medieval Architects and constructors, and altogether they helped to achieve such daring structures as the Gothic Cathedrals. Besides, the early Renaissance architects became very fond with the study of perspective. Regarding the ENVIRONMENTAL ASPECTS, the Medieval standards of hygiene fell below those of Ancient Rome.

In the late Middle Ages many royal palaces had brick sewers that discharged into the river, the main source of water supply, so epidemics were frequent and virulent, and they were so many throughout the Middle Ages.

The Roman Hypocaust was forgotten after the fall of Rome. Also the standard of lighting in the Middle Ages fell below that of ancient Rome.

Acoustics apparently received no attention in Medieval times. However, towards the end of this period, and particularly, during the Renaissance period, Acoustics were given some attention, when the theater made a comeback, especially in Renaissance Italy.

Even the Gothic Cathedrals, they too, provided a superb auditoria for Organ Music.

In the 18th C. and especially during the Late Renaissance period, there was some improvements in the Environmental aspects. Heating was some what improved compared with Medieval times. Acoustics, water supply and sewage disposal were also improved.

Much more attention was given to Architectural aspects in this period, The greater security of the Renaissance made it possible to have larger windows, which gave way to some significant innovations in the use of natural light as an element of architectural decoration, by means of using glass either colored or as it is.
Regarding the Structural problem, the elements for the solution were now available, theorems of bending, buckling and elasticity were published in the middle of the century.

Iron was now increasingly used in reinforcement just the way it is used in modern times. The Late Renaissance created a completely new type of structure, and later on highly sophisticated geometry was introduced. Towards the end of this century, and especially after the industrial revolution, the building problem was greatly affected than ever before, according to the introduction of the iron frame.

In the 19th C. almost every aspect of the building industry was already improved. Environmental design as a whole was improved. Acoustics were developed to meet the needs for new large theaters and opera houses in Paris and Rome. Fire proof structures were built using cast iron instead of wrought iron. Heating, water supply and sewage disposal were greatly improved, and sun control relied on the revival of the Ancient Greek colonnades in some parts of southern USA.

Architecturally speaking, it was the first time in the 19th C. when solutions for the Vertical transportation problem were introduced, at first as platforms for transporting goods, then as platforms for passenger transport then as closed safe cabinets for passengers.

In the 19th C. new types of buildings were introduced, such as department stores, public libraries, office buildings, railway stations and high rise structures. The use of large panels of glass became common in such buildings to allow the most of the natural lighting to enter the buildings. Improvements in glass manufacturing and natural lighting were the cause of some daring structures such as the Crystal palace in England, the Galerie des Machines and the Bibliotheque Nationale in Paris.

Besides, Prefabrication as it is known today, was not introduced in the building problem solving until the start of the Industrial Revolution.

In the second half of the 19th C., standardisation and mass production were applied to a wide variety of manufactures.

World wars I and II, helped the development of prefabricated and standardised building systems, especially after so many houses have been destroyed.
CONCLUSION:

By quickly glancing the buildings' Problem Solving in figure 3, we can notice the scarcity or lack of interest in the different building aspects Environmental, Architectural and Structural aspects of the Ancient Ages. Emphasis were given to Environmental Aspects, but chosen Architectural and Structural aspects were of no great interest to the Ancient Architects and Constructors.

During the Middle Ages, those building aspects were given some more attention than they were given in the Ancient Ages. But, Environmental Aspects fell far less below that of ancient times. However, more emphasis were given to the chosen Architectural and Structural aspects in the Middle Ages than those in the Ancient Ages.

We can also notice the great amount of interest in the 19th C. regarding the same building aspects. But then, each and every aspect was developed and improved to give a better building.

It can also be noticed that, Vertical Transportation and Prefabrication were first to appear in the 19th C.

Throughout the different ages, Architects and Engineers tried their best, according to available abilities to solve Building Problems successfully.

In modern times, Building Problems have become much more difficult. Introducing the Computer in the field of Problem Solving was a bless.

Never-the-less, a team effort is required. This team should be led by two responsible group leaders; one represents the Architect under which goes the different specialists and consultants, the other represents the Client, under which goes the different users and consultants. They must work together toward successful projects and each leader must be able to:
* Coordinate the individual efforts of his group members.
* Make decisions or cause them to be made.
* Establish and Maintain communication within and between the two groups.

Such TEAM, with good Management, could achieve the greatest mutual understanding for solving the Building's Problem.
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