Technological experimentation and heritage: the preservation of installations. [Villa Hügel, Essen].

ABSTRACT:
Only recently the discipline of architectonic heritage preservation has acquired the chapter of so-called “technical plants”. They also represent the main contribution given by the industrial revolution, since J. Watt onwards, to the building sector while introducing dynamic components and specific designing, building and assembling rules. Such solutions have followed up the historical development of architecture and technology throughout the 18th-20th century, so improving related performance levels. That has also changed their use habits – giving birth to the concept of “comfort”- as well as night-time functioning thanks to the artificial lighting of buildings and manufactured articles. There is a limited number of architectonic heritage works which are preserved because of their technologically-innovative features: Villa Hügel (1873), Essen is among those monuments whose installation features clearly prevail on its architecture.

1 INTRODUCTION

Only recently the discipline of architectonic heritage preservation has acquired the chapter of so-called “technical plants”. For more than two centuries, heating, ventilation, wiring, electrical system and water-works-sanitary devices have been included in technical testing and integrated into historical-monumental architecture. They also represent the main contribution given by the industrial revolution, since J. Watt onwards, to the building sector while introducing dynamic components and specific designing, building and assembling rules. Such solutions have followed up the historical development of architecture and technology throughout the 18th-20th century, so improving related performance levels. That has also changed their use habits – giving birth to the concept of “comfort”- as well as night-time functioning thanks to the artificial lighting of buildings and manufactured articles.

Technical plants are evidence of the technical, economic and cultural choices of a specific historical period and social context. Aim of this study is to highlight, via an example case, the design role of installations and their full introduction as design elements to be preserved.

Between representation and experimentation: the large industrial residences.

There is a limited number of architectonic heritage works which are preserved because of their technologically-innovative features: Villa Hügel (1873), sumptuous residence of the Krupps in Essen, now museum, is among those monuments whose installation features clearly prevail on its architecture. Among the forerunners of *Villa Hügel* there is also the destroyed *Palais Strousberg* in Berlin, (arch. A. Orth, 1867-‘68), the very first building in Germany to be equipped with a centralized heating radiator system (Demps, 2000).

Villa Hügel, thanks to the extraordinary financial resources of A. Krupp (1812-1887), exceeds any other previous attempt in terms of design and planning commitment.

The architectonic complex represents a *unicum* example of industrial research focused on systems and installations: built in just eighteen months, with a monumental stone shell on a load-bearing structure in steel, it required extraordinary design and production efforts. Wide glass surfaces and halls of vast size made even more necessary the construction of unique installation solutions for ventilation and radiator heating.

Villa Hügel located in Essen-Bredeney urban district, was erected in 1873 by Alfred Krupp (1812-1877), talented and despotic ancestor of the homonymous family of industrialists. The complex was originally intended as a residence and representative office. The house has 269 rooms and occupies 8,100 sqm usable floor space. The two big buildings (Large House and Small House) lie on the top of a hill overlooking the Ruhr Valley and facing the Lake Baldeney in the center of a 28 hectare park. Since 1990 Villa Hügel is a museum estate managed by the Ruhr Cultural Foundation.

The construction story (1862-1873)

Villa Hügel construction was started in 1862 by Alfred Krupp, who after the death of his father, Friedrich, took over the responsibility for the steel plant during a period of rapid economic and technological evolution in the steel industry (König-Weber, 1999). So far entrepreneurs were used to live in company's building or in a house closed to them. The acquisition of Klosterbuschhof estate in 1863 because of environment salubriousness reasons represents the turning point in the management of company's policies.

The project was conceived by A. Krupp, who besides the contribution from his own Technical Office (eng. F. Barchewitz, G. Kraemer, arch. Th. Obstfelder, J. Rasch), provided with sketches and accurate building indications for the base lines of the complex.

Feeling a deep dissatisfaction in the project development A. Krupp decided to ask for the supervison of Karl Eduard Richar Voigtel, Proto at the Cologne Cathedral Factory. The specialist was called for consultation with some of the most important professionals at that time (P.E.

Spieker, J. Emmerich, A. Orth, among others). In A. Krupp intention, the work had to be accomplished at the top technological level using industrial fireproof materials: stone, iron, glass. Endless modification requests and technical problems occurred during planning stage caused repeated turnover in construction supervision until 1873 when the complex was completed (Buddensieg, 1884).

A performance-based design brief: installation design.

Radiator heating

The requests of the Customer were clear and aimed to define performance features of the buildings at an indoor environment comfort level unattainable for that period standards (Faber, 1957). The *radiators* in each room had to have the possibility to be adjusted at different temperatures. Rooms, kitchen and toilet facilities had to be fitted also with internal ventilation systems able to eliminate humidity and emissions. Thus Alfred Krupp understood ahead of time the need to guarantee heat regulation in technical plants and thus to interrelate energy supply with room requirements. In this perspective he required the air inside the rooms to be without fumes and emissions, which was at that time absolutely common in case of local combustion systems (stoves, fireplaces).

The first system projects referred to a air heating system produced by Krupp company. It was a sort of cast iron drum with fins which had the disadvantage to be completely "at sight". For this reason Alfred Krupp opted for a system – manufactured by Berlin company C. Heckmann and produced in copper-brass pipes – using hot water at low pressure. The system was supplied by two boilers located in the centre of the west lower ground floor with supply lines located underneath the vaults of the sub-basements and ramified at right angle to the single floors. The radiators were leant to the room corners and shaped as shafts of classic columns with capitals and plinths. In the representative halls shields and panel works disguised the radiators. It's useful to point out that the single-pipe system distribution, though inefficient, was used a long time in Germany as well as in other countries until the first half of 20th Century. Its realization simplicity made it competitive with respect to other types of ring distribution. For these it was necessary to wait until less expensive solutions for welding and drawing of valves and pipes were developed and spread.

Despite of efforts and resources squandered, the heating system went out of order within some days from its activation. This caused the instant dismissal of the construction supervisor, Julius Rasch. In the year to follow the system underwent repeated repairs without however ever to succeed in meeting the wishes of Alfred Krupp, who paid a high price for innovation. The structures were subject to repeated alteration and maintenance works to adjust a technology at its very beginning but subject to very demanding challenges because of the huge dimension of the rooms to heat. The same system, installed in the smaller building kept always in perfect efficiency. The project proved to be taxing also from the economic point of view: total investment for the systems amounted to the sky-high sum of 100,000 thalers, about a sixth of the total construction cost (Föhl, 1984).

Between experimentation and test run: the first hot air heating

The heating and ventilation combined system applied by Alfred Krupp to the main plant body can be considered the prototype of the modern hot air heating systems. In 1873 a test team was appointed to complement the systems with forced suction vents, but the proposal was rejected because of high charges. Also the adoption of electric lighting system was a consequence to the need to avoid any interferences between air heating and gas lamps. We recall that in the same year Edison patented the light-bulb exactly to eliminate this critical hitch: it avoided to use gas lighting causing a range of problems linked to combustion inside rooms, to incorrect removal of fumes and to high risk of having lighting gas free in inhabited environments.

In March 1882 an emergency meeting took place summoned to replace the existing air heating by a new water system. The boiler was moved about 50 meters away from the buildings and located in an independent thermal power station. External air sucked and heated at 50°C could be conveyed up to the residence, heating the living and rest rooms besides the library, with a delivery of about 40,000 cubic meters per hour, of which 27,500 meters humidified with 213 liters of water. For a better performance of suction channels in service rooms (like kitchen, lavatories and toilet facilities) each of them was fitted with ancillary flame heating supplied with gas.

Despite of the accuracy in the devices, the test carried out during winter 1882/83 highlighted inefficiencies and critical technical troubles. The rooms upstairs kept to be cold while the cave and the rooms at ground floor were so overheated that the floor was deformed. Technical reports highlighted the system energy inefficiency which required huge amount of fuel (59.4 tons of coke and 12.1 of lignite) and an average water consumption of about 370 liters/hour. The construction of a new water supply system in 1914 improved the hot air heating system replaced by a modern steam hydro-thermal installation (Föhl, 1984).

Water Supply

Villa Hügel is an example of evolution between “off grid” independent buildings and modern urban supply networks. It offers a clear parameter how during the time the concept of plant-engineering “efficiency” concept and measurement of “sustainability” parameters in resource use evolved. Already in1862, the complexity and the huge consumption of water resources made it necessary to fit the installation of a private supply, separated from the urban network. The agreement drawn up with Prussian government allowed Alfred Krupp to collect 10 cubic meters/minute which passed to a request of 0.25 cubic meters/second justified by the request to supply also the Company workers estate with a flow of 0.08 cubic meters/second. The waterworks was fitted with three steam turbines Woolfsche-Balancier (Emsmann, 1858) used to pump. In this way the supply of a tank used in case of stoppage or failure of the motors was guaranteed and was able to ensure also the fire-fighting reserve. The basin was calculated for a 8-day requirement. The system was completed in 1874 and adjusted for higher consumptions in 1880 adding a fourth pump. The water supply had however critical technical problems: Krupp declared that “the use of toilets and fluid pressure in the pipes caused water-hammer that can be heard in any room".

In 1882 resident population in Essen progressively increased the water connections to the network causing a steady fall both of supply quantity and quality. Since 1897 drinking water had to be boiled and as an alternative, to integrate the water draw from Ruhr river they resorted to dig wells. This action anyway proved to be insufficient as in the meantime the daily volume requested by Villa Hügel increased up to 1925 cubic meters. In 1901 a new water system drawing water also from the Wolfsbachtal springs with a yearly capacity of 12,000,000 cubic meters had to be built. In 1916 the drawn water quantity reached 600,000 cubic meters (Föhl, 1984).

Lighting gas

Alfred Krupp allowed at first that inside the house only oil, wax or tallow candles could be used. Later gas lamps were installed in the areas for servants. Between 1870 and 1883 lighting of the complex was left completely to gas lamps with the disadvantage of making visible in each room the shut-off valves and the piping. The increasing consumptions of the Villa required the installation of a gas storage having an annual capacity of 360,000 cubic meters which proved to be absolutely insufficient in 1907 when the daily request reached a requirement of 2,000 cubic meters. Between 1911 and 1926 the Villa was connected to the gasification plant of Ruhr and of the city of Essen. Since 1926 the whole supply has been managed by the city of Essen. In 1935 the whole system was replaced by electric light-bulbs. The gas remained to supply kitchen stoves. (Föhl, 1984)

Electric lighting systems

The use of electric current was used already in the period of site activities and later because of introduction of telegraph. In 1880 the experimental use of electric lighting began and in 1889 was definitively introduced by Alfred’s son, Friedrich Krupp, produced by a steam generator of the Stuttgart company G. Kuhn. The consumption increased from 1150 Amperes in 1899 up to 2500 in 1905, equivalent to about 250 kW at a voltage of 100 Volts. From 1931 to 1935 the supply was assured entirely by the network supply.

Telegraph and telephone system inside and outside.

As far as telecommunication is concerned Villa Hügel highlighted the conflict of interests that Krupp had in operations and special links of private and public sectors. Many people among the workforce were contemporarily employed as public and as private workforce. The indoor telephone system was installed in 1880 and in 1883 the first telephone central office was established. Three years later the Villa was connected to an external telephone line at a connection cost of about 500 gold-marks. Besides the external telephone system there was also an internal system made of ring and valve system. The telephone central office was located in the room of the caretaker in the main body with the possibility to actuate push-buttons to call the servants or to actuate alarms (Föhl,1984).

Conclusions

The issue is about technical plants (heating, cooling, wiring, etc.) and cultural heritage, to be considered as: (a) a technical solution to solve and to support heritage conservation; (b) a "necessary evil" in order to guarantee indoor microclimate conditions; (c) or as an expression of "technical culture" suitable to heritage conservation. We believe that also this last third option should be pursued. In the broad debate between "heritage and sustainability" or "heritage and culture" we wonder which is the nature of technology, what is it and how does it evolve (Arthur,2009)? And also: which role could have technical plants and their conservation or refurbishment?

The history of thermodynamics has changed architectural history and human behavior since 19th century as central heating, refrigerators, air-ventilated and cooling, wiring and lighting systems were introduced. Those first solutions for heating, wiring and other installations have the same importance of first buildings with steel or reinforced concrete structures.

On the other hand historic buildings were fitted with several kinds of technical plants as to meet new comfort standards or new requirements (wiring, electric light, telephone etc.). In several cases owners and designers acted as if this was a "necessary evil", in other cases, as in Villa Hügel, the installation had plaid a decisive role in building planning since the very beginning.

Villa Hügel is a clear example of integral preservation based on the valorization of technological and industrial heritage which is still perfectly efficient. It also demonstrates how it is possible to preserve technological installations without musealizing or removing them only because not complying with contemporary standards.

Case studies such Villa Krupp allow to focus the research on the history of technical plant and how they have been pioneers in their first years of development, to provide innovative indoor applications. Such solutions have brought to functional changes to the buildings, requirements for indoor comfort criteria and use that have been no more perceived and accepted in a passive mode but instead with an active approach by the users and, in such case, by the owner.

Since the second half of the XIX century onwards, with the introduction of such components in architecture, buildings have been conceived no more in static terms but instead in terms of comfort and functions. Such aspect has been ignored in the architectonic debate (and still is) because, on one side, installations, plant and appliance have become independent from the building itself – as in the pioneering case of Villa Krupp - in order to follow industrial interests of production and design; on the other hand, because the research in the architectonic framework has excluded *a priori* such elements from its debate.

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