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PRESENT-DAY METHODS, YESTERDAY'S CULTURE

Knowledge is passed on in two ways: through the written and the spoken word. This produces the oral tradition and the written tradition.

It cannot be, however, that all knowledge is passed on by these two instruments alone, because every item created by human endeavour has a voice of its own. We might say that every "phoneme" and "grapheme" describing such an item was preceded by a representation of it which also revealed how it was made. If that were not the case, we would be unable to explain why in "primitive" cultures, where writing was unknown, all knowledge was passed on through the oral tradition. Clearly, in this case the actual things produced by Man passed on the culture to future generations and everyone not only remembered what he had learned but learned new things by direct observation.

Speech gave way to writing, releasing Man from the burden of memory, and at the same time reasoning developed as a method of analysis and a science so that Man was freed from the constraints of empirical knowledge alone. Writing was a means of building up knowledge which far outstripped the capacity of individual memory and, at the same time, technical knowledge became an instrument of understanding far superior to the empirical potential of experience. This means that every area of knowledge is a form of language and that all analysis requires an understanding of appropriate techniques for "decoding the message" which the created item contains.

But the knowledge contained in items is never self-evident. It is there in the form of a hint, a vestige, a trace. The job of decoding and interpreting it requires two kinds of instruments - intellectual and technical - which are developed and refined over time and which help and support each other. Clearly, however, any intellectual formulation must use both the instruments needed to unveil the secrets of creative works and the power of reason. What emerges from this decoding process is not the secrets of the laws of nature, but the messages transmitted by "architecture" and thus by human endeavour: in interpreting, we are interpreting what has already been interpreted.

At this stage the logical question to ask is how we can make our tools and methods better at "unveiling" the secrets of our architecture? Efficacity depends directly on how far the tools used can be tested and proven, the scientific logic behind them and how well they lend themselves to relativisation. As we know, these are essential elements of modern science. Science and technology are thus the best tools for analysing both natural and cultural phenomena. The technical and intellectual instruments work together and reinforce each other.

In this context, the world of architecture is very special: buildings are a mass of materials, figures, linguistic and constructional residues, static and geometrical laws, but also of man-made and natural anomalies and modifications, which cannot be studied thoroughly by just one method of analysis or even just a few specialised disciplines. Arguably the wealth and diversity of contents, causes, stimulations and pretexts offered by architecture, and the variety and complexity of its range, should - and must - be matched by an equally rich variety of techniques and forms of knowledge.

Summing up architectural design, one can say that buildings are an ensemble of figures in space, dominated by considerations of geometry and mathematics, and an accumulation of varieties, processes and behavioural laws. These features are found too in architectural theory. We find them in Leon Battista Alberti: on the one hand, form marked by proportion, metric relationships and thus geometry and, on the other hand, structure made up of weight, friction and elasticity.

In architectural design, then, structure can be read as a geometrical sequence in space and a relationship between its material components. With regard to the former, observation is paramount: it has always been the discipline *par excellence* for decoding the geometry of buildings. With regard to the latter, there is a long tradition of analysis to explain chemical, physical and biological phenomena.

Taken overall, buildings are also the site of various processes which must, of necessity, leave traces which can be variously interpreted. Of earthquakes too, which may have changed architecture radically. On the one hand they leave signs of destruction due to shaking, swaying, pulling, fracturing and other damage; on the other hand they reflect human reactions, the devices, adaptations and modifications which Man has always used to defend himself against the danger of earthquakes, learning lessons from them about new forms of construction, new devices and new techniques.

These traces can be recorded and measured. Work done in the Photogrammetric Laboratory in Venice helped us to identify similar phenomena.

In Venice some gothic palazzi, built on simple floating platforms, allowed for the fact that as the walls gradually progressed upwards, the load bearing on the platform would gradually have increased, causing it to settle gradually until it became stabilised when the building was finished and thus reached its final weight. But the builders knew that this law is valid only in theory and that in practice the structure would have gone on slowly sinking. To counter the effects of this phenomenon they built the external walls slightly jettied towards the outside and did not link the cross-walls to the external walls with ties; in this way the whole building, once completed, continued to settle until it reached its final position when it closed like a box, with the cross-walls butted permanently against the external walls, and leaving friction to provide the overall resistance of the structure.

If we discovered this jetty feature today we might think it was a construction defect or something done after the building was originally built, not realising that it is in reality a clever device and a choice which provided for the building to absorb movements and stresses which are not strictly seismic but related to the phenomenon of the bradyseism.

In this same context there is an even cleverer device to be seen in the Palazzo Corner ex Carmigiani, by Sansovino. The principal facade is on the Grand Canal, but one of its sides faces on to a small side canal. At the corner where the two canals meet, along the length of the facade, Sansovino cut a groove in the masonry, virtually invisible to the naked eye, being concealed in the interior by pointing, bosses, cornices and mouldings. This cut helps to absorb any upthrust of the building, which is more likely at this corner.

These techniques were identified using high-precision photo-grammetric surveying methods.

These two examples straight away show us two things: firstly, they prove that an understanding of the phenomena of the slow seismic shock and subsidence, typical of the Venetian subsoil, led Venetian builders to allow for the possible effects of these phenomena on architecture; secondly, that the availability of adequate techniques of measurement and geometric analysis enables us to recognise geometrical anomalies (jettying) or a discontinuity in materials (Sansovino's groove) as clever constructional devices which one cannot always identify by traditional methods of observation.

Admittedly, the problem of distinguishing between signs which reflect deliberate construction choices and others which are purely fortuitous persists. We must not forget that buildings are an accumulation of traces which may depend on inexperience, deliberate or chance material and geometric modifications, on factors extraneous to the builders' choices. When performing our analysis, we thus have to try to assign the traces which our instruments record to the correct category of phenomena. But we must not think we can give an exhaustive answer to this question by merely touching on the complexity and interrelationships of analytical methods. Unfortunately, architecture suffers from a long tradition of empirical analysis which was rough-and-ready and prone to error from the start. Architecture needs to find its own best way of harnessing scientific research, beginning by putting some order into its system of analysis, creating a serious classification of techniques, procedures and the phenomena analysed and distinguishing between the various phenomena: between natural and deliberate phenomena, between coincidences and rules, between successful completions and anomalies. Only in this way can observations, data and information be classified so that verifiable reports and opinions can be compiled from them.

All this is made necessary by the fact that architecture presents as a complex range of phenomena, so that an equally complex range of techniques is required to study it. But it is inconceivable that one sector of technology alone could encompass the whole of the phenomenon in question. We have to learn to manage our techniques in all their complexity and diversity. We have available instruments which are increasingly sophisticated for chemical, physical, biological, metrical analysis, but their products and the results of their use are scattered over thousands of research reports which are not coherently organised because they are self-contained and separate initiatives. There is no machinery for regularly monitoring the development of these phenomena over time, in cycles determined in advance. Essentially, there is no collective repository for storing the knowledge which is in the process of being accumulated, and methods have not yet been discovered for studying and comparing data from differing origins. Take, for example, the reluctance of historians to accept thermoluminescent dating. And yet we know that whilst science uses axioms and theorems based on a logic of the homogenesis of similar phenomena, it is true too that it relates phenomena which appear to be different and alien to each other and is thus able to make "discoveries". Perhaps we need to be scientifically more flexible and investigate possible correspondences between phenomena which are profoundly different.

What are the possibilities if we systematically compare historical or bibliographical data with metric, photogrammetric, thermographic data, with data based on thermoluminescence, dendrology, biological analysis of lichens, fungi or moulds, with chemical or physical analyses of materials and processes of gradation, etc., with micropalaeontological analysis of rocks aimed at identifying the quarries they came from and their distribution?

It is clear that we are not yet ready to build these relationships and make use of every possible type of analysis. But this is the road we must take, drawing up specific agreements to coordinate and use the synergistic benefit of all these inputs so that we can have a solid body of analytical data which are relevant to architecture.

These reflections also give rise to a number of problems in connection with surveys of architecture at risk from earthquakes: one concerns techniques of metrical reporting; the other is more general and concerns the interpretation and management of knowledge.

For the structural analyst the use of measurement has two contradictory aspects: on the one hand one uses general recording methods which most of the time cannot be verified because they were applied without rules for their implementation and verification; and on the other hand one makes specific localised measurements on processes and fractured areas, installing electronic extensimeters, high-precision fleximeters and deformeters which measure tiny fractions of a millimetre and thus yield extremely sophisticated data. Clearly, correlations cannot be made using data of such widely differing kinds. Specific measurements, taken using very high-precision instruments, will always be highly localised verifications, totally distinct from the building context, whilst