

**PLAN AND SPECIFICATION OF AN ARCHITECTURAL SURVEY:
THE PALAZZO DELLA RAGIONE (PD)**

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ABSTRACT

The Plan of the survey of the Palazzo della Ragione (Padua, Italy) and its Specification prove a guide for reaching the correct conclusion of a architectural survey, where the first defines the rules of the method and the second verifies the respect. Both constitute the body of the method and form the basic structure of the scientific character of the metrical survey discipline.

THE METRICAL UNDERSTANDING OF THE ARCHITECTURE, THE PLAN AND THE SPECIFICATION FOR THE PHOTOGRAVIMETRIC SURVEY OF THE PALAZZO DELLA RAGIONE.

Introduction

We measure the environment that surrounds us through its buildings, buildings that involve man, man who planned and constructed them, who studies them, who uses them, who preserves them.

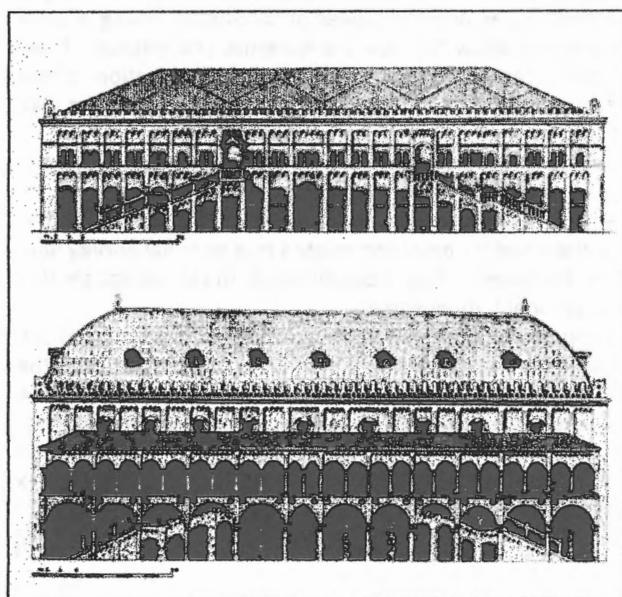
From here we have the need, first and foremost, for a Plan for the survey and specification that anticipates and reports the rules of the proper use during the construction of the survey itself. The Specification must range from the administrative rule to the technical ones, clearly specifying how the measurements must be conducted and what the obtainable exactness is in every phase of the survey itself. This occurs in phases, one after the other, and each of

these phases must be tested individually. As in classical cartography and more generally in any survey, the testing must happen in the course of the work and not only at its outcome. It is this test, done as the work progresses that can guarantee the excellent quality of the work; the final test can indicate that the survey has been executed correctly or not, but in the case that it is not, it can only ascertain the failure of the operation. The only solution to this problem is to make adaptations of the work already done, but it is well known that this is generally impossible. Compromises therefore must be reached that have nothing to do with a job done according to the "rules of things done right." The Project first and therefore, the Specification, are looked at as a guide for reaching the correct conclusion of the job, where the first defines the rules of the method and the second verifies the respect. Both constitute the body of the method and form the basic structure of the scientific character of the metrical survey discipline.

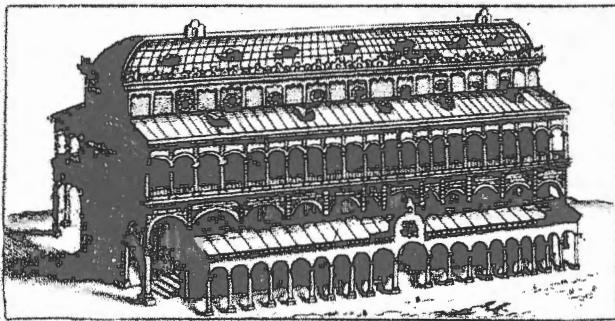
The Plan and Specification are to be seen as guides for arriving at the correct completion of the job, so it is necessary that there is constant collaboration between who executes the survey, who directs it, who tests it and who will use it. The Plan and Specification together make up the body of the method in which the former defines the canons and the latter ensures the observation of these. Both form the main structure of the scientific character of the discipline of metrical survey of architecture and they make up the widest and most vast scientific discipline of the survey.

A scientific discipline must have rather well defined limits. Many obstacles interfere with the reasonable definition of these limits: the different languages of the various users of the space in which the discipline is practiced, the differing cultures of these same users, the practical techniques of some and the abstract techniques of others, the scant knowledge, intentional or not, of the reciprocal positions of the technicians operating in the field of architecture, the ever present historicism, at times a dominating characteristic, of many.

In this light the Plan and Specification of the survey of the Palazzo della Ragione can be seen beyond their ordinary function as a guide for the survey and can rather make a contribution to the definition of the discipline of the metric survey of architecture.



The façades of Palazzo della Ragione: historic image



Axonometrical view of the Palace: historical image

THE METRICAL SURVEY OF THE PALAZZO

Instrumental and methodological aspects

The spectrum of the methodologies and the instruments that are used in the architectonic survey is greater than ever, and reaches from common methods, although not for this reason less noble or useful, to those sophisticated ones, such as indirect measures beginning with direct measures, or indirect beginning with intermediate stages on which one measures directly and then, with the opportune algorithms, the direct dimension of the object is transferred.

Exemplifying what has been stated, it is meant the measurement of a room with the classic longimetric triangulation, the determination of the position of remote or inaccessible points with the measurements of the angles and the distances, the photographs on which, with proper shrewdness, the measurements can be taken and hence transformed in position coordinates in an opportune system of reference. The first two procedures are individualized in

the methods that classic topography has taught us, where the reconstruction of the surveyed object is done by plotting points, and therefore adequate, made continuous by the continual interpretation of the visible. This is the presumption on which the method is based: that which is metrical in the survey of the Palazzo della Ragione is surveyed or can be deduced by the survey. That which is herein affirmed has its consolidated experience and is completely valid.

Talking about a continuum and therefore about photography, the metricality of the survey, we cannot but think about photogrammetry, a technique that even though it is not very complicated is not even one of the simplest either. The Specification must call for the methodology that must be used in order to operate secondary phases such as the following, referred to and described in general. This must define the technical instrumental instructions, the accuracies that must be obtained, the sensitive material and its treatment, the methods and the quality of the graphic, numerical and digital representation, and the testing procedures.

The topographical nets

The first plane-altimetric and second order nets make up the structure within which the survey is built and are well defined within the Specification.

They must be realized with superabundant measures, such as will allow for statistically valid controls.

The scope of the nets, as is well known, are:

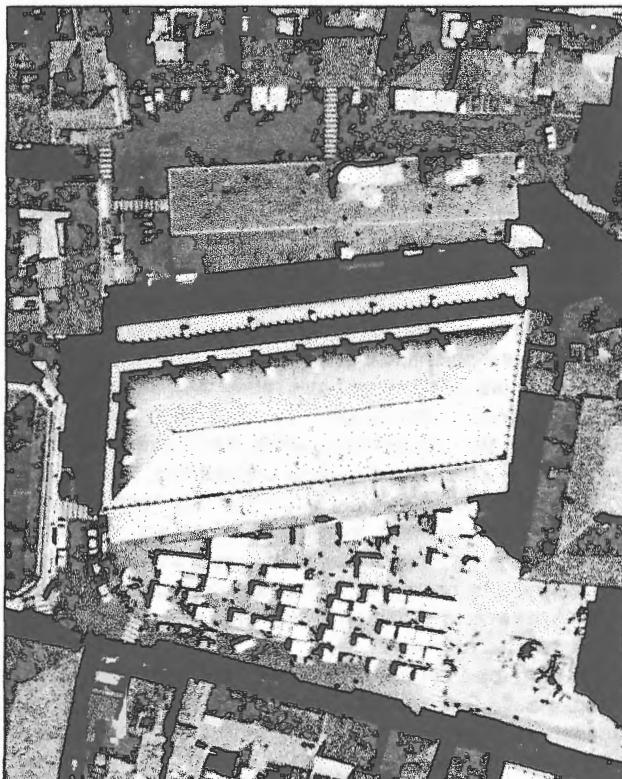
- the determination of the scale of the photogrammetric models and their absolute orientation;
- the survey of plans, façades and sections;
- the referentiation of the parts of direct survey.

The photographs

This is characterized by the internal orientation and by the parameters that define it. These are determined with the same precision of thirty years ago, but today the analytic methodologies and the power of calculators make it more simple and allow for new instrumental procedures. Even all the rules that require a constant verification of the establishment of the time of the orientation parameters take on a different light in modern photogrammetry.

The Specification therefore must call for photos both with traditional metrical cameras and with alternative instrumentation (semimetrical, non-metrical, digital) in order that the need for precision related to a nominal survey scale is honored. The Specification must establish this acquisitional survey scale.

The operative situations in close range photogrammetry are much different and create problems in the orientation of the photos. The spaces at the disposition of the survey of the Palazzo della Ragione fortunately permit photos at normal axes and therefore a stereoscopic vision which permits continuity, of primary importance in the restitution of complex architecture.



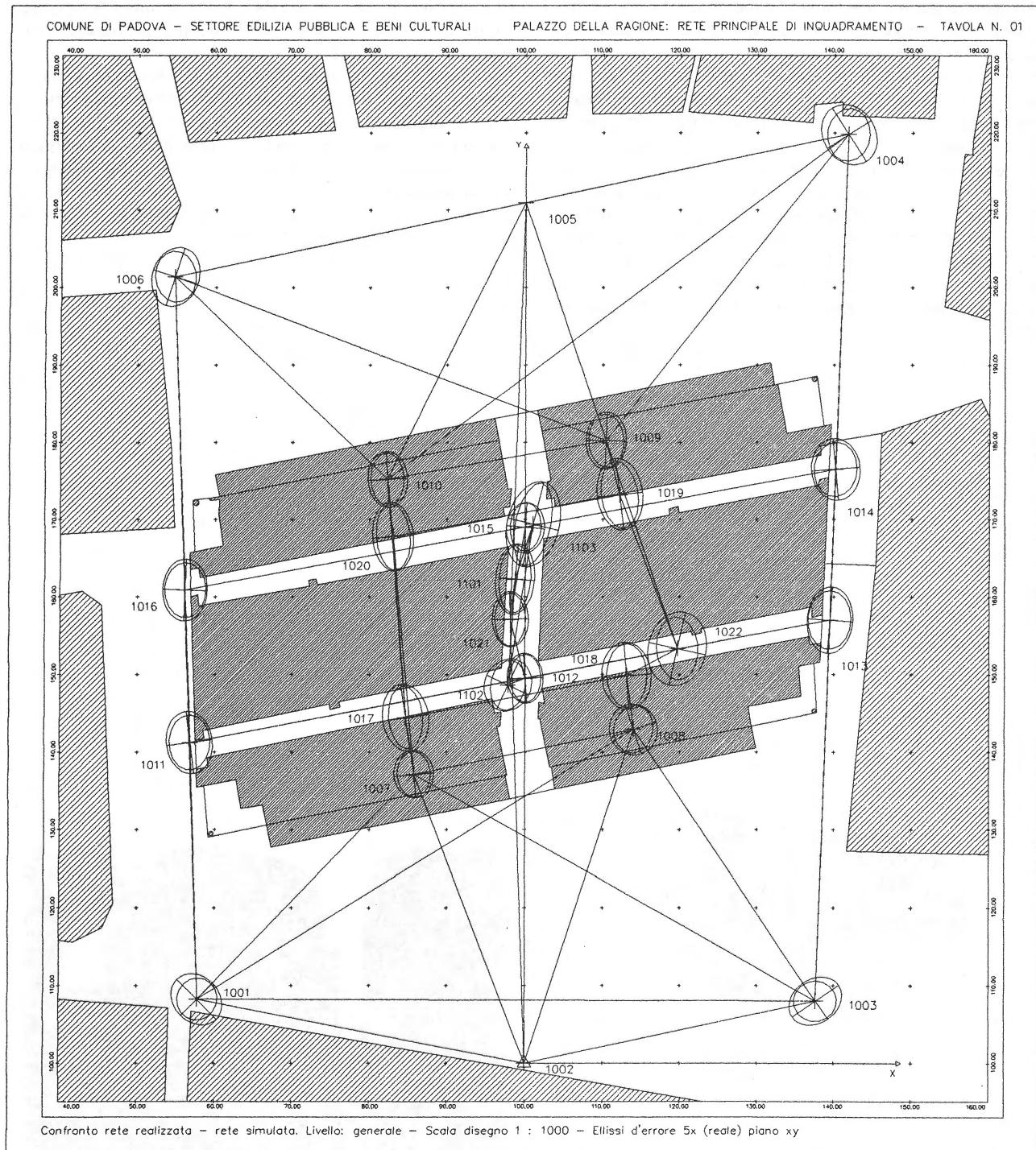
Aerial photo of the Palace in the historical centre of Padua

Operative problems related to the determination of support points

In the table of the specifications called for by the Specification it is necessary to activate processes of simulation which permit the choice of instruments, the operative methodologies and the topological diagrams for the survey of control points, keeping in mind that the topographical needs are affected by two factors:

- that the support point is clearly visible on the photograph,
- that this is well defined.

The two factors are easily resolved and can be signaled by points before the set points, something always auspicious and generally possible. Where this may not be possible, the choosing of the natural well defined particulars, equivalent in fact to signaling, is called for. The number of control points must be such to ensure a correct external orientation. The topological diagrams of photographs and support must be such to ensure a homogenous uncertainty on the three point coordinates.



Scheme of the first order net with the overimposition of the simulated net

Relative problems of the photogrammetric restitution and the editing of the Palazzo

The choice of the restitutitional instrument is fundamental. Its characteristics must be precision, productive economy, versatility. There is no doubt that today one cannot but think of analytic or digital instruments, even if this does not exclude the possibility to resort to analogic instruments equipped with automatic registration of the coordinates. In the restitution the binominal man-machine is explained: it is essential that the operator has practice in the restitution of architecture, because this is very different from the restitution of terrain. He must find the observed image and through this completely describe the object and above all that which in the image can be translated into lines. These, whether straight lines or curves, in reality don't exist, but together reproduce the object in form and position and make up the reasonable descriptive reduction of the concept itself of the object.

The restitution is only a numerical form, it comes from a dense line of coordinates, one following after the other, memorized with proper codes and acquired through software that express the numerical coherence between the coordinates themselves. This coherence is fundamental in maintaining the unitarity of the object and the non coherences are immediately perceptible by enlarging the

images to video. It is senseless therefore to talk about the scale of the restitution, because in video one may enlarge or diminish however much is wanted, and one may also plot to the scale that is required. Therefore, nominal scale is referred to, intending with this term the fact that the photogrammetric operation has been planned for a certain scale with its uncertainties, valid at that scale, but the numerical-vectorial reproduction of the restitution permits graphic reproductions and observations in video at differing scales.

The numeric restitution must keep certain standard formats for which the use is by now a rule in the field of surveyors, for example the DWG or the DXF AutoCad, maintaining the possibility to export the numeric designs, preparing them for reading by the GIS.

The Specification is precise for the points touched on here. Another point on which the Specification gives instructions is the characteristics of the hardware and the software for the editing phase. The operations that in this phase must be anticipated are the codifications on the restituted objects, on the geometric integrations, on the reconstruction of the geometric congruents, and on the operations for the reconstruction of the aggregations.

RILIEVO PALAZZO DELLA RAGIONE

RETE PRINCIPALE DI INQUADRAMENTO

Monografie dei vertici di rete

Località: Padova

Nome punto: 1004

Descrizione punto: pozetto UNI EN 124 C250

Coordinate (m)	SQM (mm)
X 141.7509	0.7
Y 219.7539	0.8
Z 10.4082	1.2

RILIEVO PALAZZO DELLA RAGIONE

Monographic card of the topographical point of the first order net

Integration of direct and photogrammetric methods.

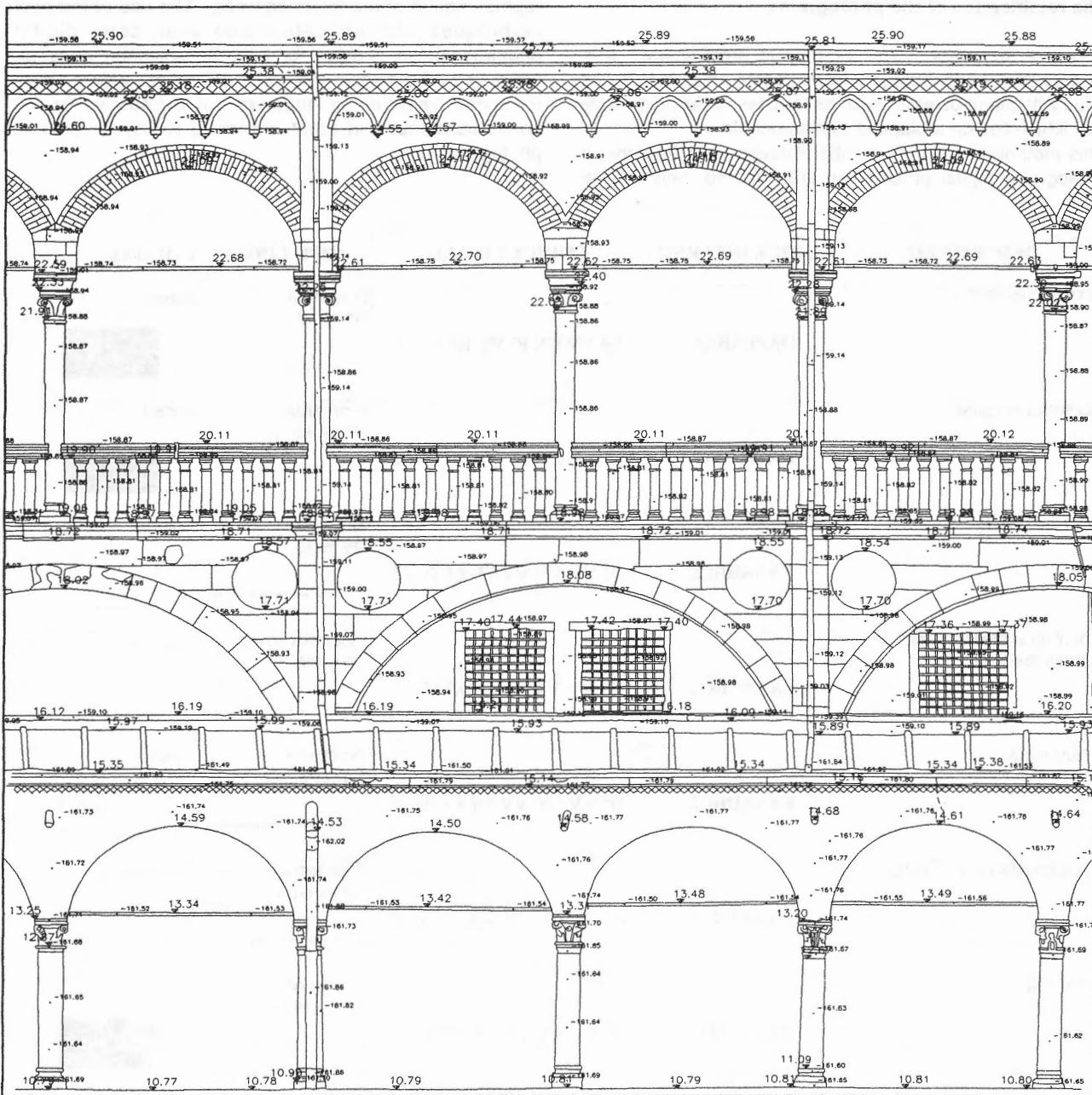
The survey of a complex architectonic organism, rich in structural asymmetries, in ornamentation related to the style in which it was built, requires measurements of a structural kind, that much more correct and consistent with the scope as also more imposed in a logic of comprehensive homogenousness, especially having to do with the need for the accuracy of the survey itself.

Photogrammetry satisfies this most in the survey of façades, of planimetry, but cannot be ideal for the survey of horizontal or vertical sections for the reason of the difficulty in observing a correct base/distance relationship.

That which immediately gives an idea of just how difficult and often impossible it is to utilize the photogrammetric method for surveying vertical sections is this: think of the

faces of a nave or similar structure. It is necessary, therefore to reserve for photogrammetry the metrical description of façades, surfaces with a prevalently two dimensional development, leaving the survey of sections to the other methods.

The section is of extreme importance, if surveyed in a way metrically correct, both for the metric description of the object and more importantly, for the static analysis of the building. This is obtained with topographical and direct methods, these days based on the use of distanceometric instruments. In the case of an important and complex survey, this obliges an accurate plan of the nets because every point obtained with photogrammetry in direct survey, using topographic methods for polar coordinates, must correspond to a unique system of reference.



Sample of the photogrammetric restitution of the façades of the Palace

campo 1 struttura	campo 2 tipo	campo 3 elemento	campo 4 materiale	campo 5 alterazione	campo 6 provenienza	campo 7 tipo-linea	campo 8 colore
campo 1: indicazione di carattere tipo-morfologico come ad esempio: strutture verticali, orizzontali, superficie di rivestimento, coperture, collegamenti verticali (scale), iscrizioni, ecc.;							
campo 2: indicazioni morfologiche strutturali, come ad esempio: arco, colonna, pilastro, capriata, travatura, ecc.;							
campo 3: specifica ulteriore dei campi 1-2 come ad esempio: base (01), fusto (02), capitello (03), chiave di volta;							
campo 4: indicazioni sul materiale costituente, come ad esempio: mattoni (11), pietra (12), legno (13), ferro (14), ecc. con eventuali specificazioni particolari dei materiali come ad esempio il tipo di pietra, essenza del legno;							
campo 5: indicazioni sullo stato delle entità specificate nei campi precedenti; andranno quindi indicata la presenza di fessurazioni, fratture, sbreccature, corrosione, assenza di materiale, segni di umidità di risalita, distacchi di intonaco, ecc.;							
campo 6: provenienza del dato, come ad esempio: rilievo fotogrammetrico, topografico, diretto, digitalizzazione di							

Structure of the data files

The rectification of the photograms

This is a technique quite common in architecture. It is evident that the technique is proposable only when it has to do with plane objects, such as façades of buildings: only that which lies on a plane is restitutable.

This method is called for in the Palazzo della Ragione, if analogic or digital procedures are adopted, only for the

representation of the frescoed walls. The use of the new techniques of rectification and even color digital photomosaiculture is called for in the Specification, as an alternative to the classic analogic rectification, which allows for those "restitutions" that are not exhaustive or not convenient (case in point: frescoed walls) for classic photogrammetry.

DESCRIZIONE	CODICE INTERNO	CODICE FINALE	TIPO LINEA	COLORE
CORNICI IN PIETRA	DAZFABA1	04 VV CN PI VV RF 01 01	CONTINUA SPESORE 0,1	ROSSO
CORNICI IN LEGNO	DAZEABA1	04 VV CN LE VV RF 01 01	CONTINUA SPESORE 0,1	ROSSO
FESSURAZIONI	EAAABBF2	05 VV VV VV FE RF 06 02	TRATTEGGIO A SPESORE 0,2	GIALLO
DISTACCO DI MATERIALE DI RIVESTIMENTO	EAAACBG2	05 VV VV VV DI RF 07 02	TRATTEGGIO B SPESORE 0,2	GIALLO
FRATTURA	EAAADBC2	05 VV VV VV FR RF 03 02	CONTINUA SPESORE 0,2	GIALLO
MANCANZA DI MATERIALE	EAAAEBG2	05 VV VV VV MA RF 03 02	CONTINUA SPESORE 0,2	GIALLO
MACCHIE	EAAAFBH1	05 VV VV VV MC RF 08 01	TRATTEGGIO C SPESORE 0,1	ROSSO

Codification of the architectonic elements

Representation

The Specification gives explanations, through attached examples, of the graphic quality of the designs, of the methods of execution, of what must be understood to be the originals of the design.

It specifies the final documents to have in advance and to deliver to the customer and specifically:

1. the photographic material
2. the topographic material
3. the computer material
4. the graphic material.

It specifies the documents to deliver in their numbers: plans, prospects, sections, rectifications.

These specifications are necessary in order to avoid misunderstandings between subjects involved and above all in order to guarantee the coherence and homogenousness of the representations. Coherence means that all of the two dimensional documents must be able to be superimposed without incongruities; homogenousness means that the graphical quality of all the documents must be the same, even if they come from differing survey procedures and restitutions.

The fact that the monument is represented in all of its parts and according to the method most consistent with the characteristics of its architectonic elements is also fundamental.

Numerical design and Codification

Just as indications are given about the final graphical documents, the rules for the structuring of the numerical designs are referred to as well. The final end is that of differentiating as much as possible the architectonic elements that together make up the Monument. The disaggregate data allow for varied point readings and a structurazation is estimated using codes utilizable with the various CAD and GIS systems in order to preserve the totality of the information.

Following is the structurization foreseen by the Specification as a minimum basis for needs related to the articulation of the Monument.

Testing

The specification defines and indicates the responsibilities of the Works Management and the Tester. It lists in detail what the procedures of the testing during the work are, the documents to deliver to the tester at the end of each phase. It has to deal with the survey testing and more precisely, of the following phases:

- structural nets and supports nets,
- photographic reproduction,
- restitution,
- recognition,
- file editing,
- design.

It prescribes the rules of the final test, indicates the times and methods of the drawing up of the relation and wording of the final test, the rules for the measurement of the surveyed surface.

For an exact description of the contents refer to the general index of the Specification:

PART ONE: ADMINISTRATIVE INSTRUCTIONS

CHAP 1:	CONTRACT
CHAP 2:	TIME OF EXECUTION
CHAP 3:	PENALTY
CHAP 4:	ANNULMENT OF CONTRACT
CHAP 5:	PAYMENTS
CHAP 6:	RESPONSIBILITIES AND OBLIGATIONS OF THE CONTRACTOR

PART TWO: TECHNICAL INSTRUCTIONS

CHAP 7:	CHARACTERISTICS OF THE SURVEY AT A NOMINAL SCALE OF 1:50
CHAP 8:	CONTENTS OF THE SURVEY AT THE 1:50 SCALE
CHAP 9:	METRICAL ACCURACIES OF THE NOMINAL 1:50 SCALE
CHAP 10:	PHOTOGRAMMETRICAL SETTINGS AT A NOMINAL 1:50 SCALE
CHAP 11:	FIRST ORDER NET
CHAP 12:	SECOND ORDER NETS
CHAP 13:	NETS DETERMINING THE CONTROL POINTS TO THE PHOTOGRAMMETRIC MODELS
CHAP 14:	RESTITUTION
CHAP 15:	RECOGNITION
CHAP 16:	EDITING
CHAP 17:	RECONSTRUCTION OF THE CONGRUENTS
CHAP 18:	LOGICAL AGGREGATIONS
CHAP 19:	NUMERICAL STRUCTURE OF THE DATA FILES
CHAP 20:	DESIGN
CHAP 21:	GRAPHICAL DOCUMENTATION

PART THREE: JOB AND TESTING INSTRUCTIONS

CHAP 22:	JOB INSTRUCTIONS
CHAP 23:	TESTING
CHAP 24:	DOCUMENTS TO DELIVER TO THE TESTER AT THE END OF EVERY PHASE
CHAP 25:	TESTING OF THE INDIVIDUAL PHASES OF THE CARTOGRAPHY

PART FOUR: CODIFICATION AND GRAPHIC SYMBOLS

CHAP 26:	CODIFICATION AND GRAPHIC SYMBOLS
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PART FIVE:

APPENDIX:	PRINCIPLE INSTRUCTIONS FOR THE EXECUTION OF THE AEROPHOTOGRAMMETRICAL SURVEY OF THE ROOF OF THE PALAZZO DELLA RAGIONE AND THE SURROUNDING BUILDINGS
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