AEROPHOTOGRAMMETRIC IMAGES IN A QUALITY REGIMEN

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ABSTRACT

The ISO 9000 rules, which have introduced the "Quality System" for the production of goods and services, have been taken up by the more industrialised countries with the objective of assuring the level of necessary prerequisites through control procedures and eventual corrective action during the work cycle.
In the field of numeric cartography, the approach according to standards of quality includes all the stages: design and drawing up of specifications, flight, photogrammetric imaging, acquisition of the photographs, positioning, contouring, printing and final inspection.
Applying a series of programmed "on line" checks to the production cycle, according to the fundamental principles introduced by the Quality rules, assures the achievement of the required specifications, while not waiting for the final inspection phase for verification that could come too late.
In this paper we review the guidelines of the ISO 9000 publications and we analyse some critical aspects of the production cycle.

1. INTRODUCTION

The ISO 9000 legislation that has introduced the "Quality System", parallel to the extension of the market towards greater and more international dealings, has changed the strategies for production and the development of companies.
The creation of a company policy aimed at the production of a "Quality System" requires a new organization of work in the company, which starts at the managerial level and includes all those who take part in the production process.
In particular, it is important to guarantee that the product or service that is provided satisfies the needs that are expressed or implied by the client, in order to create trust both inside and outside the company, be it public or private.
In the area of numeric map making using aerophotogrammetric pictures, the management of the quality involves all the construction phases: the project, realization, testing.
To subject the production cycle of map making to a series of "on-line" programmed checks, according to the fundamental principles of the legislation, assures the fulfillment of the specific requests.
This aspect is particularly important for the production cycle under examination, in as much as the traditional methods of testing can lead to a late recognition of errors that cannot be modified and therefore prejudice the correctness of the map.

2. REQUISITES FOR A QUALITY SYSTEM

ISO 8402 defines system quality as the organizational structure, the responsibility, the procedures, the processes undertaken for the management of the company for quality.
From this definition it is clear that quality is not referred only to products/services, but to the entire management and control of the activities present in the company, by which the production of the product is reached.
The legislation of the ISO 9000 family (figure1) give the principle rules both for the definition of a quality system and for its relative application, giving a guide to the management of quality and the general requisites for guaranteeing it.
In particular, the ISO 9000-1 is the instrument for the approach to the whole legislative packet, in as much as:

- It clarifies the principal concepts connected to quality and the relative distinctions and interrelations;
- It gives a guide for the choice and use of the ISO 9000 legislative family for a correct running of the company for quality.

In general, the creation of a System Quality is a complex process and aimed at the improvement of the level of a product or service, and it develops through the phases of: plan; do, check, and act, following the so called Shewart cycle or Deming's ring.
All this can be translated in the creation of a quality plan, that, in relation to the product/service, establishes the operating methodology, resources and the sequence of activities that influence the quality of the product. In particular the plan defines:

- The objectives of quality to carry out;
- Distribution of responsibility;
- The procedures and the work instructions to apply;
- Control methodology.

At the same time a "Quality Manual" is created that illustrates the quality program of the company and the criteria to establish it, therefore becoming an instrument of presentation for the company to the outside world.

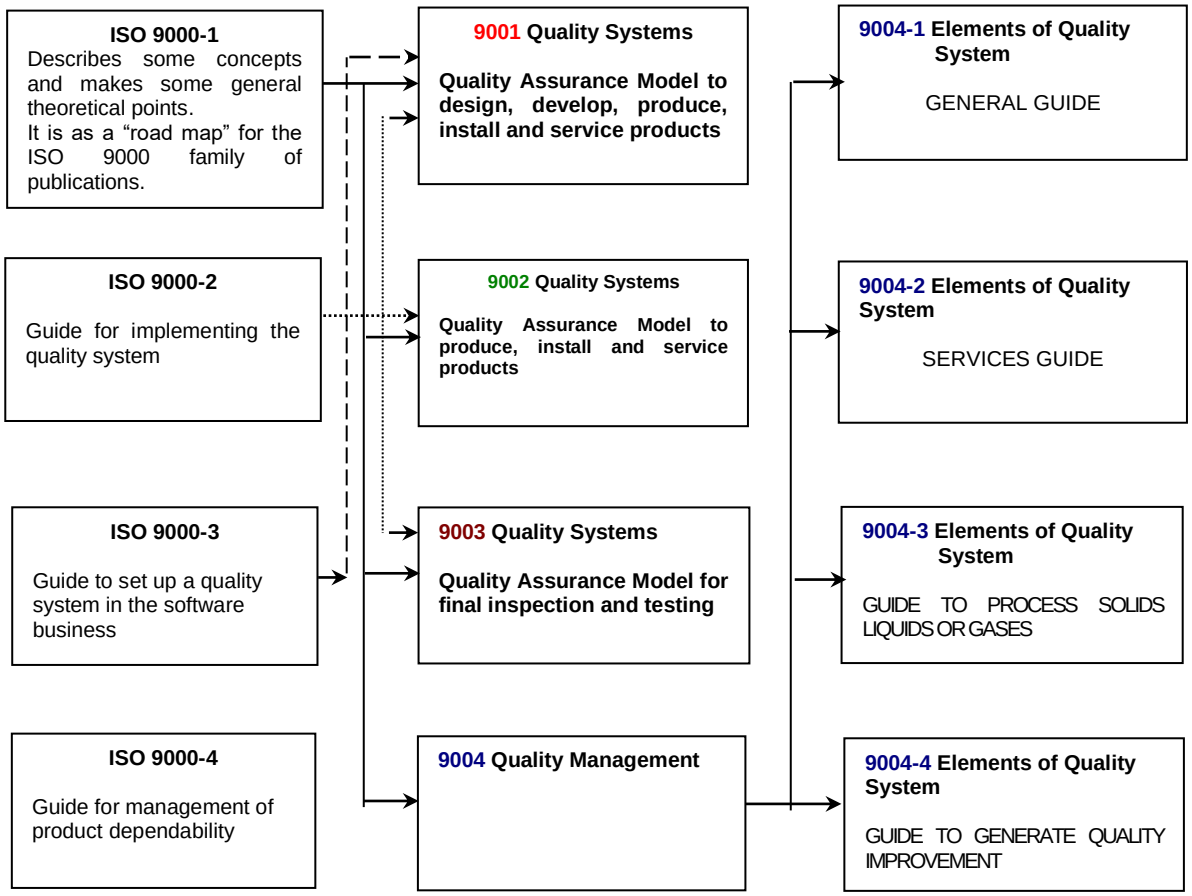

Figure 1 – ISO 9000 publications

3. THE PRODUCTION OF NUMERIC MAPS IN QUALITY REGIMEN

With reference to the legislation, cartography is a service for the client, connected, however, to the realization of a tangible product, the result, that is, of a defined process, in which the requisites are expressed by a project and a specification.

This is, in fact, something that is not permanent and lasting, in as much as in the moment that it is created it could already be surpassed, in part, thus it is not possible during the project phase to establish how long the product will last.

For the production of quality, the *ISO 9001* can be applied and the conformity is obtained by means of an adequate demonstration of the capacity of the provider in the activities of design and production.

In the case in which the activity of the company is only productive, implementing technical specifics, the certification of quality, limited only to the production and not to design, can be obtained according to *ISO 9002.*

For "design" we mean all the activity that leads to the technical specifics that represent the terms of reference for the "final (or executive) design" as explicitly, or implicitly or potentially specified by the client. Even when conformity is limited to ISO 9002 the geo-topo-cartographic companies have to have an *organization structure* with qualified personnel able to finalize the technical specifics following pre-established procedures.

The first stage to establish a quality system is the identification of the objectives to follow.

Numeric cartography represents an instrument/service for the client (public or private body) for the knowledge more or less specific of the land with the aim of being able to constitute a valid base for successive actions of design, planning, studies for forecasting and simulation, etc.

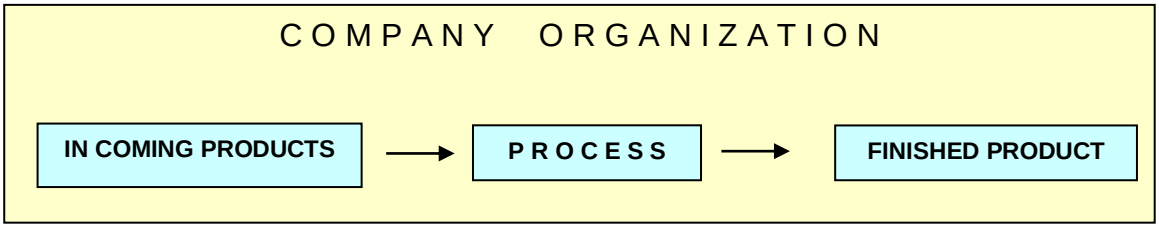

Figure 2 – Company organization

It is, however, of fundamental importance to assure the quality in a relationship to the following principal properties:

- technical standards and metric tolerances;
- legibility, possibility of being updated, reliability;
- ample intrinsic information content;
- maintenance of the above characteristics.

In order to apply the ISO 9001 the fundamental aspects connected to the production cycle have been analyzed (figure 3).

3.1. Company organization

In general, the first thing to do in a company to assure that the path towards total quality is well understood, carried out and sustained at all levels id that of defining the organization chart of the company structure and the responsibilities of each component of the system. In this environment it is necessary to establish the figure of the quality coordinator who will represent and translate at the various company levels and in all departments the will of the management to apply this policy.

The legislation states, furthermore, that within the productive unit the producer should:

- ❑ Company organization;
- ❑ Final Design (flight, topographic network, information structuring of data, etc.);
- ❑ In coming products;
- ❑ Production process;
- ❑ Finished product.

The most important parts of each phase have been identified defining the essential requisites for a production in a regime of quality.

- guarantee the free circulation of procedures that have been documented, reviewed and approved by the Administrative Technical Management;
- archive the documents of the registration of quality that are necessary in order to demonstrate the conformity of the product to the specific requests of the client;
- carry out inspections in the company to show eventual deficiencies or bad functioning of the whole and complex quality system;
- promote professional training courses in order to have efficient staff ready to resolve any problems connected to the actuation of total quality.

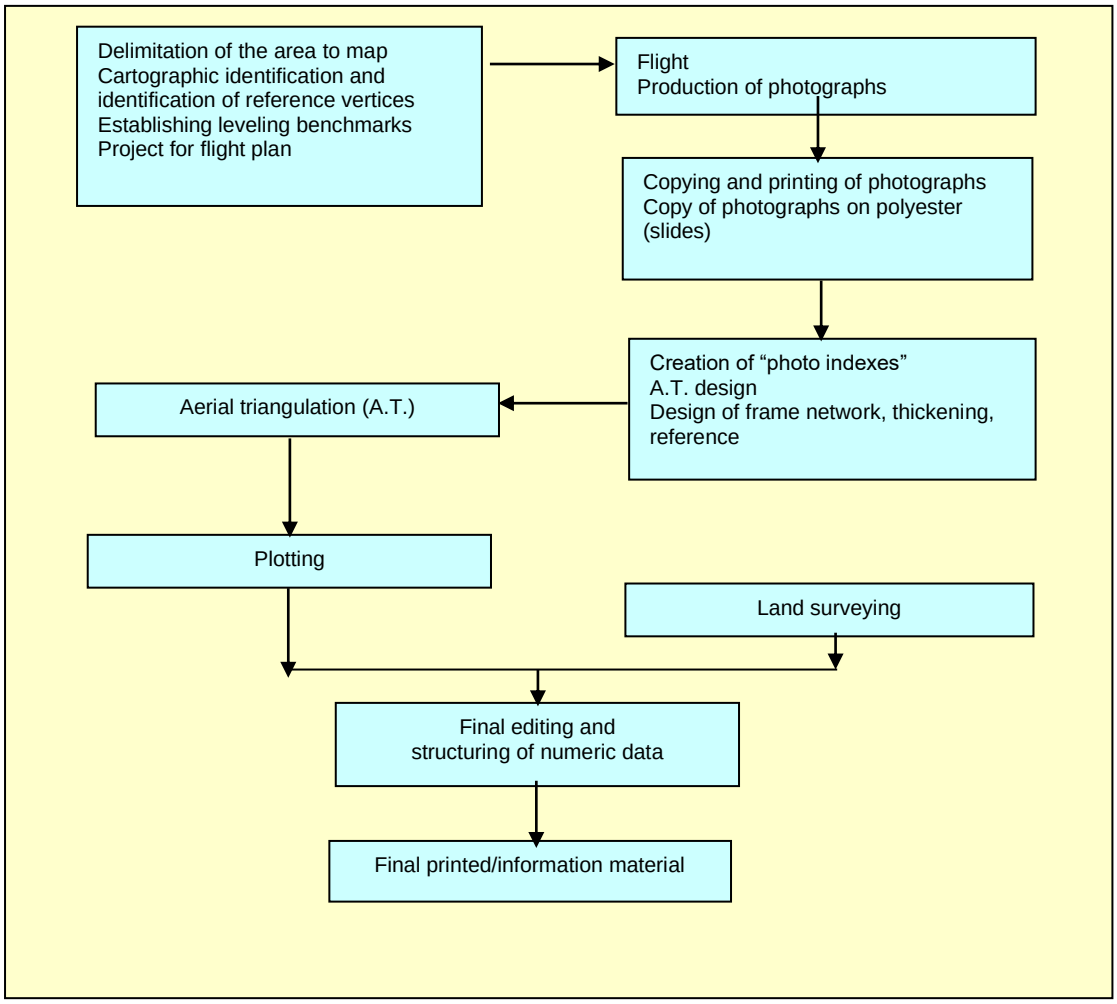

Figure 3 - Plan for the production of maps using aerial photographs (Galetto R., Spalla A.,

3.2. Design

The "design" for the geo-topo-cartographic sector generally requires *technical specifics* based on the needs of the client (public or private). These specifics define the characteristics of the "product" and of the relative production process, establishing, in particular, data content, accuracy, logical and geometrical congruence, exchange protocols, etc.

In "design" the activity finalized for the definition of new procedures and technology is also included.

The "final design", on the other hand, includes the actual implementation of the indications that are included in the technical specifics, establishing the operational details.

Schematically, for numeric cartographic production, the design includes the following:

<u>*general design*</u> (plan):

- definition of technical specifics;
- definition of general requisites to carry out the works;
- definition of possible new procedures and technology;

<u>*final design*</u>:

- *flight plan*
  - delimitation of the area and orthographic analysis;
  - strip design and relative flight altitudes based on the predefined photogrammetric scale;
  - superimposition of the photograms and determination of the number of photos for each strip;
- *aerial triangulation*:
  - design, based on the "photo index" relative to the flight, of the A.T. blocks, with the identification of the reference points (constraint) and the A.T. link points;
  - identification on the photograms of the reference points with characteristics of "photographic identification", to be determined in the field by topographic methods;
- *setting, thickening and topographic references*:
  - cartographic identification and tracing of the extant plane-altimetric reference vertices in the zone and inspection;
  - design network of planimetric and altimetric thickening
  - definition of instrumentation and methodology of examination based on the necessary precision;
  - design for the plane-altimetric network of the reference points identified during A.T. design;
- *data structuring:*
  - design for the information structure of the numeric data, based on the specific needs of the client (G.I.S., themes, etc.).

The general and final design need certification according to the *ISO 9001* standards while in the case of only the final design *ISO 9002* could be sufficient for certifying the producer.

In order to proceed to the design phases, it is important that the producer has acquired the data and the requisites on which to base the realization of the product, including those compulsories for legislation.

The results of the design phase must be documented and expressed in such a way that they can be verified and validated.

This means carrying out, as is stated in the legislation, procedures of re-examination, verification, and validation of the design with the aim of assuring the congruity and coherence of the work carried out.

3.3. In-coming products

As regards the production of numeric maps the in-coming products, which are necessary for the various phases of the production cycle, can be grouped according to the following plan:

- *photographic products* (films in b/n - color – infrared – etc, sensitive photographic film, development products, etc.);
- *support products for cartography*;
- *finished photographic products* (photograms);
- *intermediate and final paper support products and final printed material* (polyester, plotter paper, ink, etc.);
- *electronic support products*

When establishing the materials necessary for the project they must conform to the specific requests.

All of this is carried out through "documented procedures" aimed at the evaluation of sub-contractors in relation to their capacity to satisfy the required requests for the in-coming product in terms of characteristics and quantity on the one hand, and the definition of the documents relative to the acquired data, which must completely and univocally describe the requisites of the ordered products.

Therefore, it is necessary to:

- classify the sub-contractors by certification or on the basis of previous supplies;
- register the data to acquire and checking for the up-dating of what has been mentioned above;
- define in a univocal way the object, quantity, time and condition of delivery, special needs for packing and transport.

Furthermore, it is opportune that the contract stipulates that the client can verify the conformity of the products used by the supplier.

The supplier must confirm the conformity of the product to the requirements by means of documented and registered procedures. Any sub-supplier should provide certification on the checks carried out at the moment of sale.

The methodologies and the frequency of checks on the material should be defined based on the degree of importance that they have on the process, the products inherent variability and the reliability of the sub-supplier as defined in the setting up supplies stage. This requires the development of a true sampling plan based on a profound knowledge of the product in such a way as to estimate the parameters with pre-set levels of confidence.

In general, all the in-coming material will be checked by its freight bill in order to verify its correct origin and its conformity to the sales agreement and a preliminary visual check to see if it looks "normal".

3.4. Process control

All the moments of the production cycle that have a direct consequence on the quality of the product must be identified and it must be assured that they are controlled. Therefore, the following must be applied:

- Documented procedure relative to the flight phase;

- Documented procedure relative to the development and printing of the films;
- Documented procedure for the verification of the photogrammetric coverage and the scale of the photograms;
- Documented procedure relative to the A.T. phase and topographic measurements
- Documented procedures relative to the modalities of copying, with particular regard for the classification and interpretation of the elements, phase completion times and the checks to be carried out on the areas that are not directly visible;
- Documented procedures relative to the land survey stage, with particular regard for the instrumental campaigns of the elements of the territory that are not visible in the photographs; sample verification of the metric standards;
- Documented procedures relative to the phase of electronic elaboration of the maps;
- Instrument maintenance to assure a continued process capacity.
- Check of conformity of the quality plan;

Naturally, documented procedures must be actuated for the registration of the checks carried out during the process to be correlated to the finished product and its destination.

3.5 Finished product

The finished product is the numeric map, or geographical data base, its fundamental property is responding exactly to the morphological and anthropical situation of the surveyed area.

Therefore, even if the production cycle finishes with the consignment of the map and the information in electronic form, the supplier must guarantee the results above all the technical-administrative verification and testing carried out at the end to verify the quality of the operations carried out.

3.6. Contract re-examination

With reference to the product, and to the tests carried out to verify that it satisfies the required requisites, the contract re-examination is aimed at verifying that:

- the final characteristics of the product are “adequately defined and documented”.
- the requirements conform to what is offered;
- the supplier is able to satisfy the requisites indicated in the contract and can guarantee the tests required.

3.7. Preventative and corrective actions

The verification of the conformity, also following complaints by the client, activates the process of identifying the possible preventative/corrective actions by which the cause can be eliminated and the repetition of analogous situations avoided.

These procedures include complaint management, identification of the cause, definition of preventative/corrective actions and the verification of the efficacy of corrective actions.

4. CONCLUSIONS

The production of “quality” numeric maps allows, through the programmed actuation of documented procedures in the various phases of production, to guarantee the desired characteristics.

The study of the ISO 9000 legislation and the analysis of the production cycle of the “map” product/service have allowed the evaluation of the fundamental aspects for the creation of a “Quality Manuel” for the aerophotogrammetric based cartographic production.

In this paper our attention has been focused on the aspects of the production cycle that have a direct influence on the quality of the product, showing, in particular, the importance of defining control procedures for the complex phases of design, of verifying properties and accepting in-coming materials, as well as the production cycle.

It must be said, furthermore, that in the area of a Quality system, the training of staff and the prevention of accidents at work play an important role.

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