

EASEMENTS AND PROTECTED AREAS: PROBLEMS AND EVOLUTION OF THEIR GRAPHIC REPRESENTATION ON URBAN DEVELOPMENT AND CIVIL ENGINEERING DRAWINGS.

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ABSTRACT:

The constraints that urban development or civil engineering projects impose on certain areas often establish on them certain easements that must be specified in various graphic documents. These easements are constituted from the planning, or are represented by imposition of other organisms in order to establish the proper functioning and protection of infrastructures. The graphic representation of these “limitations” is significant and consistent enough in urban and/or civil engineering plans to perform its corresponding analysis. However, it should be stressed that one should not confuse the graphic representation of the easements and protected areas established and/or represented in the planning with protected areas of land, that may be so due to a variety of reasons -natural parks, land reserved for various uses or infrastructure, etc. and which, in this case, would be related with the classification and use granted through regional plans and programmes.

Key-words: Graphic representation, Civil engineering, Easements, Protected areas.

1. INTRODUCTION

This article focuses on analysing the problem of the graphic representation of the limitations that urban planning and civil engineering impose on certain areas of the planned territory establishing an easement on a part or portion thereof. These limitations may encompass from the protection of areas in riverbeds for safety reasons due to possible flooding, areas in which the height of buildings is restricted or they are prohibited due to their proximity to airports or their approach and take-off areas, road, track or railway easement areas, easement areas of supply network facilities, above or below ground, and the list goes on.

2. METHODOLOGY

The subject of graphic expression and its realization is, in most cases, based on observations and data provided by the senses, data that often have more to do with perceptions and feelings rather than with absolutely reliable data. So, assuming this difficulty from the outset, it is necessary to pose with sufficient clarity the initial questions to be solved, as well as the limits and constraints of the research framework. In the case in hand, the lack of specific and concrete literature as well as research or articles published on the subject in question requires the production of a series of data from the fusion and interpretation of bordering themes that do not specifically refer to the background of the

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work in question. Nevertheless, the works conducted and published by Jaques Bertin (1998) on graphic representation and semiology should be highlighted.

These works, despite being highly technical and hardly specific to the issues under consideration, continue to be the general foundation on which to base any subsequent reflection concerning the problems and optimization of graphic representation, including purely technical graphic representations. Thus, this work addresses the analysis and development of the graphic encoding of easements and protected areas from the detailed observation of various urban planning and civil engineering documents found. All of these documents show or should display the areas affected by easements, brought about primarily by various networks of urban services or territorial infrastructures.

The work performed is based on the collection and observation of different urban planning and civil engineering projects, naturally in significant numbers, then the identification and classification of the different characteristics of graphic representation used for the representation of easements and protected areas.

First, we proceeded to compile planning drawings published in various books or articles, considered sufficiently significant of the different periods, techniques, methods of representation, methods of reproduction or printing, etc. This initial collection of drawings was conducted from a primarily qualitative point of view and considering a geographical area limited to the so-called western world.

The collection of drawings and the establishment of the sample under scientific criteria were performed through extensive as well as sufficiently indicative and representative fieldwork, also spanning rather a significant time period. The collection and cataloguing of these planning documents begins systematically from 1980 and extends to 2009. The fieldwork consisted of the observation, photography and analysis of civil engineering documents, town planning drawings and urban development projects. The sample was limited to analysing medium-sized towns of Catalonia (5,000 to 30,000 inhabitants). The definition and selection of the sample were performed on the basis of probabilistic criteria and forming a significant sample.

The drafting of plans of this type of towns and settlements basically involves the intervention of a sufficiently indicative sector of the group of technical officers dedicated to urban development, planning and civil engineering. Larger towns or cities or excessively small settlements could cause a dispersion of expertise or non-expertise among the planners, which we have sought to avoid. From the data obtained, we proceed with a detailed analysis of the evolution of the graphic aspects examined, establishing a time thread in the transformation and evolution of the graphic parameters and resources used in the graphic representation of easements and protected areas.

The final cataloguing of the results and variables was performed from the analysis of the graphic resources used to draw the easements and protected areas, with special emphasis on data relating to the types of graphic resources used to realize them, and that include the study of the characteristics of the lines, the use of patterns and textures, the texts and typefaces, the techniques of reproduction or printing, and delineation techniques.

2.1. CATALOGUING OF RESULTS AND VARIABLES

Results and variables were catalogued by performing two separate tasks. Initially, the graphic resources used to represent easements and protected areas were analysed. Thus, data were collected from the observation of the graphic documents of the selected sample of the

types of graphic resources used to render a representation on paper of easements consisting of the study of the characteristics of the lines, the use of patterns and textures, types and features of the texts used, and reproduction and delineation techniques. Various aspects of these graphic resources were analysed according to the following table of data collection:

<p>Features of the lines</p> <p>Predominant thickness</p> <ul style="list-style-type: none"> • 0'1 mm. • 0'2 mm. • 0'3 mm. • 0'4 mm. • 0'5 mm. • 0'6 mm. • 0'8 mm. • 1'2 mm. <p>General range of thicknesses</p> <ul style="list-style-type: none"> • 0.3/0.5 mm range • 0.8/1.2 mm range <p>Type of line used</p> <ul style="list-style-type: none"> • Continuous • Dashes • Dots • Dash and dot <p>Use of colour</p> <ul style="list-style-type: none"> • Yes • No 	<p>Texts</p> <p>Predominant thickness</p> <ul style="list-style-type: none"> • 0'1 mm. • 0'2 mm. • 0'3 mm. • 0'4 mm. • 0'5 mm. • 0'6 mm. • 0'8 mm. • 1'2 mm. <p>Font</p> <ul style="list-style-type: none"> • ISO • ROMANS • ARIAL • Others <p>Use of colour</p> <ul style="list-style-type: none"> • Yes • No <p>Reproduction techniques</p> <ul style="list-style-type: none"> • Heliographic • Photocopy • Original 	<p>Use of patterns and textures</p> <p>Predominant thickness</p> <ul style="list-style-type: none"> • 0'1 mm. • 0'2 mm. • 0'3 mm. • 0'4 mm. • 0'5 mm. • 0'6 mm. • 0'8 mm. • 1'2 mm. <p>Typology</p> <ul style="list-style-type: none"> • Uniform • Geometric pattern • Organic <p>Application technique</p> <ul style="list-style-type: none"> • Drawn • Adhesive <p>Use of colour</p> <ul style="list-style-type: none"> • Yes • No <p>Delineation techniques</p> <ul style="list-style-type: none"> • Manual • CAD tools
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The data have been reviewed and annotated using the criteria of awarding an absolute value to the most commonly used option. That is to say, often cases have been observed in which a particular aspect being evaluated involved various typologies of the same graphic resource on the same plan; for example, given the case of the interchangeable use of continuous lines or dashed lines to proceed to the graphic representation.

This being so, the annotation criterion has always been the same and the most used or prevalent value or parameter in the plan has been adopted as the sole one, for subsequent evaluation and statistical treatment. Finally, it must be stressed that the majority of parameters can be evaluated at a glance, without any great difficulty for any technician with experience in the preparation of urban or civil engineering plans.

2.2 THE PROBLEM OF REPRESENTING EASEMENTS AND PROTECTED AREAS

The easements and protected areas that can be seen in urban plans are not always a direct result of an urban planning process. The emergence of these limitations and easements on a part of the territory is often the result of operations from different technical disciplines. Pure urban planning is not always the main cause of the establishment of easements. And neither does it have to be the management and planning of the territory that physically and conceptually surpasses an urban plan limited to the scope of the municipality and/or its district.

The presence of different kinds of pre-existing factors, of environmental conditions, of nature protection plans, of delineations of large infrastructures -existing or planned-, of

various safety factors, of the protection of historical-cultural elements and environments, of special reserved areas, as well as a whole range of other possible and variable factors, can limit and restrict use, occupation, activity, etc. in various parts of the territory, and from a higher sphere than pure municipal planning. These conditioning factors, moreover, though not having a direct relationship with urban planning inevitably dominate it.

However, easements can also be detected that are generated solely by the planning drafted or by a civil engineering project. This is true, but as a general rule it can be said that the restrictions that easements and protected areas establish on a “conventional” urban management plan are due mainly to the needs of access, maintenance and expansion of supply networks, on the one hand, and, usually, supramunicipal conditioning factors, on the other.

At the same time it can be concluded that, except for the elements of protection of natural and historical-cultural spaces, it is often the elements that pertain to the delineation, construction or installation and maintenance of infrastructures, of any kind and category, that are the main generators of easements and protected areas in the territory. Therefore, we find ourselves in the difficult borderline area shared by the disciplines of urban planning, civil engineering, supramunicipal or territorial planning.

The sample studied has examined planning and civil engineering documents subdivided into three distinct time periods: the first extends from 1980 to 1989, the second from 1990 to 1999, and finally the third period spans from 2000 to 2009. Reviewing approximately 50 urban planning and civil engineering documents has involved the inspection and analysis of about 1200 drawings and/or graphic documents. The temporal stratification of the sample was carried out following intentional criteria, splitting it on the basis of sufficiently relevant periods as regards the evolution and change in the delineation and reproduction techniques used in graphic documents.

It has not been possible to locate plans prior to the periods of the sample analysed showing the representation of easements and/or protected areas on planning plans. This shortcoming is probably due to the fact that most published plans that are easy to get access to and consult corresponding to the first half of the twentieth century, are most specifically urban plans. However, neither should we ignore the possibility that, during this period, this aspect of planning was despised, or simply ignored, by planning officers when establishing or representing it on urban plans. In any case, ascertaining the above circumstance exceeded and departed from the aim of this article.

It should be noted that, as mentioned, the literature on this issue of the graphic representation of urban planning is scarce indeed. Normally, the authors that have dealt with this subject, like, for example, Hecce and Magrinyà (2002). Jude and Matkin (1983) or Santamera (1998), have done so from a project and technical point of view and not from the purely graphic point of view of its representation.

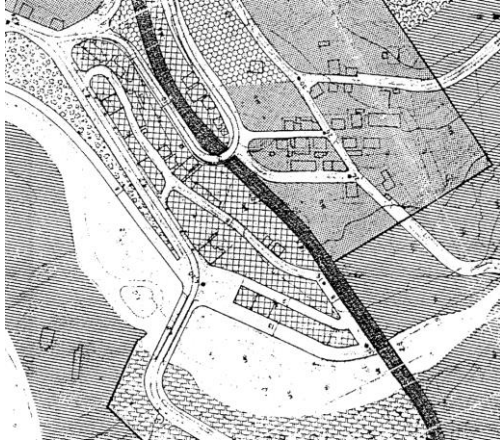
However, it is particularly interesting to see how scholars of the history of urban planning and the development of cities very often incorporate examples of plans of urban supply networks in their publications but not of the easements they create in the territory.

This is the case of authors such as Bosma and Hellinga (1997), Boyer (1986), Bosselmann (1997), Peterson (2003) or Scott (1995). Only French organizations such as the “Conseil National de l’Information Géographique. Groupe de travail -Informatisation PLU-” (2006) or the “Conseil National de l’Information Géographique. Groupe de travail - Numérisation des PLU-” (2011) have worked on the approach to graphic solutions based on semiological and visual perception studies encompassing the optimization of the solutions applicable to planning and civil engineering plans, and among them, the representation of easements and protected areas.

3. THE EVOLUTION OF GRAPHICS

3.1. 1980-1989

Main graphic characteristics of the period 1980-1989 (**Fig.1**):



Lines: Mostly not available
Predominant thickness: 0'2 mm.
Range of thicknesses: 1'2/0'8 group
Types of lines used: Dashed lines
Colour: Black and white

Patterns and textures: Mostly not available
Predominant thickness: 0'2 mm.
Typology: Geometric pattern
Application technique: Adhesive
Colour: Black and white

Text: Mostly not available
Predominant thickness: 0'2 mm.
Typography: ISO
Colour: Black and white

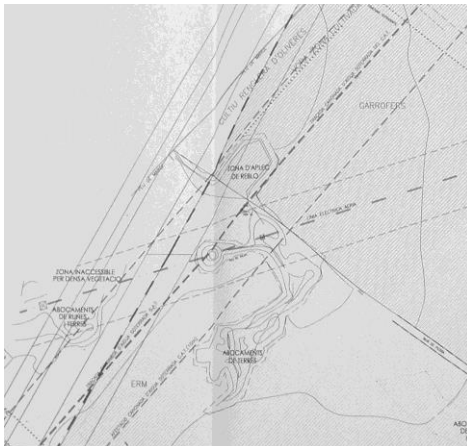
Reproduction technique: Heliographic
Delineation technique: Manual

Fig. 1. Representative example of graphic font of the period 1980-1989 (Authors' files).

Note, “*Mostly not available*” indicates that in more than 50% of the graphic documents consulted from the period in question, easements or protected areas are not drawn at all, or if they are drawn, the established graphic resource has not been used. The data subsequently annotated correspond to the data obtained from the rest of drawings from the period that despite being a minority do have the easements and protected areas drawn.

3.2. 1990-1999

Main graphic characteristics of the period 1990-1999 (**Fig.2**):



Lines:
Predominant thickness: 0'3 mm.
Range of thicknesses: 0'3/0'5 group
Types of lines used: Dashed lines
Colour: Black and white

Patterns and textures: Mostly not available
Predominant thickness: 0'2 mm.
Typology: Geometric pattern
Application technique: Adhesive/Drawn
Colour: Black and white

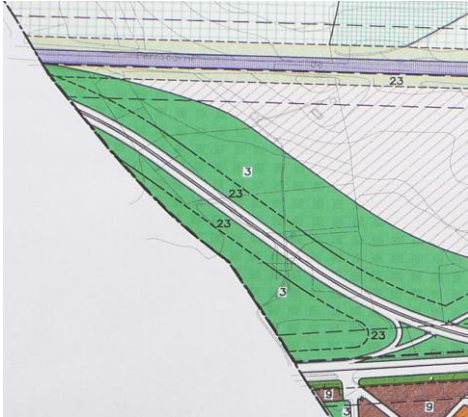
Text:
Predominant thickness: 0'3 mm.
Typography: ISO/ROMANS
Colour: Black and white

Reproduction technique: Heliographic
Delineation technique: CAD tools

Fig. 2. Representative example of graphic font of the period 1990-1999 (Authors' files).

3.3. 2000-2009

Main graphic characteristics of the period 2000-2009 (**Fig.3**):



Lines:

*Predominant thickness: 0'5 mm.
Range of thicknesses: 0'3/0'5 group
Types of lines used: Dashed lines
Colour: Black and white*

Patterns and textures: Mostly not available

*Predominant thickness: 0'1 mm.
Typology: Geometric pattern
Application technique: Drawn
Colour: YES*

Text:

*Predominant thickness: 0'3 mm.
Typography: ROMANS
Colour: Black and white*

Reproduction technique: *Printing of originals*

Delineation technique: *CAD tools*

Fig. 3. Representative example of graphic font of the period 1990-1999 (Authors' files).

3.4 CHARACTERISTICS AND REFLECTIONS ON THE EVOLUTION OF GRAPHICS

Observing the sample of plans analysed it can be said that in around 30% of all of the plans of the studied sample, it was not possible to detect specific representations that could determine, locate or indicate easements or specific protected areas. Now, it should be pointed out that over 50% of the plans in which these determinations were not drawn correspond to the first period -1980/1989-. Thus, the plans consulted in which there is no indication whatsoever of easements or protected areas are located mainly in documents that developed partial plans or detailed studies, where it should be taken into consideration that, in all likelihood and within their scope, it did not make sense or it was not applicable to represent any easement or protected area as it either did not exist or the need did not arise. Considering the purely graphic theme of the aspect studied in this paper, curiously it can be seen how in the few documents from the first period that graphically show easements or protected areas, they are determined almost entirely by applying adhesive patterns or geometric patterns. It should now be added that the graphic solution that is applied to represent easements in the planning documents of the last two periods studied, compared with the usual application of the adhesive patterns used in the first, is certainly different.

During the last two periods the use of patterns, adhesive or drawn, is virtually non-existent, being replaced by the illustration of lines limiting the areas that are protected or reserved for easements of some sort. These limiting lines are rendered mostly using discontinuous lines, preferably avoiding variants of dash and dot and continuous lines. In addition, the gradual introduction of colour throughout the third period hardly alters the traditional black and white representation of these lines. During the second study period,

the absence of patterns that graphically accompany and complete the areas affected by easements is virtually total. This is not so in the third period.

Although not sufficiently relevant or significant, it happens that in some documents from the period 2000/2009, some easements indicated with the corresponding discontinuous lines are complemented graphically by the use of colour patterns.

The possibility of the introduction of colour to drawings would seem to facilitate the incorporation of this useful visual resource more generally in urban planning documents and, of course, also in the representation of easements generally speaking. However, this is not so in the sample studied, its use being rather scarce. This colour limitation became especially forced during the first two periods of the sample, simply due to the fact that the techniques of reproducing plans that were used did not allow colour reproduction at a reasonable cost. However, during the last period of the sample, in which wide-format colour printers started to allow the reproduction of plans in colour and with no special limitations - not even economic-, it is significantly evident that most technicians prefer to disregard chromacity for the representation of easements and protected areas.

Another notable graphic feature is the inverse evolution followed by the thicknesses applied to the graphic resources and lines used to indicate the limits and environments of easements and protected areas. Indeed, the thicknesses used to represent plans in each and every one of the different graphic aspects that can be represented in technical drawings for planning and civil engineering decrease significantly and successively over the three periods. Now, an inverse evolution is notable as regards the limits of easements and protected areas. The thicknesses with which the technician applies the different graphic resources (in this case basically dashed lines) increase as we proceed through the three periods of the sample. Of course, immediately the question or debate may arise that would try to ascertain and solve the reasons for this apparent contradiction.

In graphic representation, the thickness or boldness used to draw a line is determined by the importance that is wished to be given to the object delineated. Thicker or darker lines have traditionally served to highlight the importance of the object delineated or represented. Therefore, it is probably the awareness and sensitivity of the technicians in view of the increasingly important definitions, locations and clear establishment of easements and protected areas that have caused this gradual increase in the thickness with which the lines showing easements are drawn.

If we refer to the texts that appear indicating annotations and references about easements, no notable variations can be appreciated during the first two periods studied. Only during the period 2000-2009 is a change clearly manifested in the typography used. If in the two previous periods, the typography used was almost solely "ISO" and "ROMANS", during the last period studied various typographies appear of different nature, although "ROMANS" predominate. This gradual evolution that involves the passage from "ISO", used during the first period and shared with "ROMANS" during the second, to other typographical models in the third, is explained simply by the delineation technique used during the different periods studied. In the first period the delineation technique was essentially manual and in the third it is with the use of CAD software.

In the transition period, the second, both typographic typologies coexisted. The use of templates for manual stencilling, during the first two periods of the sample, and their final replacement by the use of computer tools, during the third, explains why the use of the various typographies supplied by CAD programmes are those that, without questioning their suitability or lack thereof, started to become commonplace.

The last two aspects of graphics, that are no less remarkable for their obviousness, reveal, in the first place, the step by heliographic systems of copying and reproduction used during the periods 1980-1989 and 1990-1999, to the direct printing of originals that, thanks to the conclusive implementation of CAD systems, became definitely incorporated during the period 2000-2009.

The second observation is obviously the logical and manifest transformation in the delineation techniques of drawings, with manual drawing on vellum, vegetable or polyester paper, common in the first period, to the gradual introduction of CAD tools during the second, ending with the full and definitive incorporation of computer assisted drawing programmes in the third.

4. THE PRESENT

In the plans observed dating from after the period analysed, no major graphic innovations and no sufficiently significant new variants are detected that transcend the features already observed in the third sample period. However, it should be pointed out that the progressive and effective incorporation of colour, also in the representation of easements that are drawn in urban plans, becomes, without doubt, as novel a trait as it is significant.

Undoubtedly the incorporation of colour may be the biggest novelty in the specific drawing of easements that has been observed in plans beyond the year 2009. However it must be said that the incorporation, virtually without exception, of colour is a common graphic resource in any urban planning or civil engineering plan subsequent to the period 2000-2009.

The symbolisms and graphic resources used to represent easements and protected areas are highly variable and in many cases depend on the specific feature of the easement that the plan indicates. Drawings have been observed ranging from those that only show routes and easements of facilities and supply networks, to other, far more complex ones that delimit areas of influence and protection of infrastructures. In all cases it is the technician who chooses what he believes to be the most appropriate mechanism to represent the easement clearly.

The use of colour combined with other graphic resources is the usual solution, although it does not always have to be so and, in some cases, the use of patterns and textures in black and white facilitates the inclusion of a categorization that at no time interferes with other possible categorizations made using colours. Thus, this mechanism of superposition is another resource that technicians allow themselves to facilitate the addition of information to a plan without causing any particular confusion to the reader.

As has already been mentioned, the comprehensive document comprising modern town planning is completed with a series of thematic plans. It is often found that each of these thematic plans contains different aspects of the town that are represented simultaneously. However, it has also been seen that other urban planning elements require a plan in which these elements are represented principally and practically exclusively.

In the case of the representation of easements and protected areas one can find that technicians use both options. In some urban planning documents their representation shares one of the many thematic plans that integrate it. In others, a plan is drafted specifically, exclusively representing the easements and protected areas within the territory or scope of planning developed by the plan.

Without a doubt, the massive addition of colour to plans has made their reading and understanding easier. And, at the same time, it has enabled superimposing graphics without fear of causing confusion or misunderstandings, to indicate and represent more items on the map. The plan that can be seen in **Fig. 4** is a typical urban zoning map showing the grading and classification of the planned territory. In it, two clearly different graphic levels can be observed. The first forms the base map and makes us of pastel colours and greys so as not to make the plan excessively dense. The second level, drawn in far more vivid colours, categorizes the land and also the easements and protected areas.

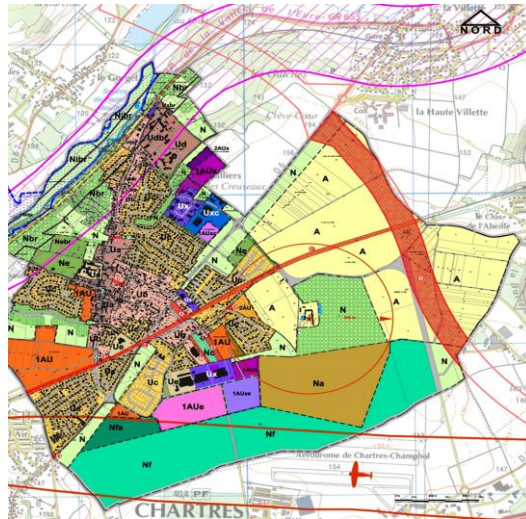


Fig. 4. Plan of the “Local Urban Planning Plan” of the municipality of Champhol –France-, 2013.

The plan shows the different zonifications of the municipality but includes the existing protected areas and easements. Marked with a circle in the centre of the plan is the protection area of a historic monument. To the north of the municipality, in fuchsia or pink, and inner striped pattern at 45°, and to the south of the municipality represented by two orange lines are the areas of influence and protection from the noise of the railway line and aerodrome. To the east of the municipality illustrated and filled in orange are the easements and spaces reserved for major roads and motorways. Finally, to the north-east of the municipality, shown in a thick line and blue dashes, the limits of the flood areas are indicated. Thus, we can see how the addition of colour allows visual and graphic diversity which without colours would be quite impossible, and it allows adding other elements for representation which without the use of this resource would be difficult to incorporate. However, the increasing importance of the concepts of easements or protected areas often leads the technician to devote a plan exclusively to these items. The significance and limitations involved in easements (both from a purely legal point of view and from the physical aspect of land use or limitation) causes, as one of the thematic plans that integrate them, the planning document to include a plan clearly specifying and concretizing (and without additional planning concepts that cause confusion) the clear and concrete representation of the easements and protected areas that affect the scheduled territory (**Fig. 5**).



Fig. 5 Plan of the “Local Urban Planning Plan” of the town of Dieue-sur-Meuse, France, 2010.

5. CONCLUSION

The study of this historic process must be rather rigorous, but, when performing it from a purely graphic point of view, one must step back far enough to achieve an overall appreciation of the matter, allowing oneself not to be especially picky in each and every one of the small changes, although significant, which might divert our attention to issues that are graphically too superfluous and more related with the historical development of cities and urban planning than their representation. Thus, a more integral and less detailed vision of the influence and importance that easements impose on the design process of urban elements, from supply and communications networks to global urban planning, enables, quite easily, establishing a process of sufficiently indicative and remarkable graphic incidents, which are the mechanisms and resources that have been used to represent them, and what was the origin and the reason for their implementation.

The influence of what might generically be called instrumental techniques, and which include both delineation and drawing techniques, including materials (ink and media) and tools, and printing and/or reproduction techniques, are particularly significant factors in the development of the model of representation of both urban planning and of its derived plans such as civil engineering plans. These changes in the instrumental techniques that have arisen throughout the historical process, have taken place parallel to some conceptual changes such as the increasing importance acquired by the correct indication and definition of easements and protected areas existing in a territory.

This introduction of changes in instrumental techniques seems not to have ended. At present, consulting town plans via the website of a municipality whether on the screen of a computer or tablet, is replacing the traditional use of paper to consult urban planning documents. At the same time, the progressive use of photoplans, used as “base plan” for projects, is likely to produce further changes in the graphic approach of future urban planning and civil engineering documents that will also affect the graphic representation of easements and protected areas used to shape them.

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