

TECHNIQUES FOR ESTABLISH OPTIMAL VALUES OF DIMENSIONING VARIABLES USED IN CORRECT PRINTING OF THE TECHNICAL DRAWING

TEHNICI DE STABILIRE A VALORILOR OPTIME ALE VARIABLELOR DE COTARE PENTRU IMPRIMAREA CORECTĂ A PLANȘELOR DE DESEN TEHNIC

SLONOVSKI A.¹, PRUNĂ L.¹

e-mail: andreislonovski@yahoo.com

Abstract. The achievement, with the computer graphics help, by using AutoCAD software, of the technical drawings is apparently a well-known issue by many of users. But the multitude of stages that lead, finally to the printed form of a technical drawing, starting with the loading and establishing the properties of the layers and ending with the printing process, makes this action to be not an easy task. From practical experience, the authors know the fact that between all the stages required to obtain the printed form of a drawing the phases that may pose the most problems are in number of three. The first is the one that refers to the choosing a standard format for printing. The second takes into account the case when the users can not represent or represent incorrectly, on the same format, multiple representations using different scales. Finally, the third concerns the situation in that the users can't indicate the representation scale. Taking to account these inconvenient, the authors have developed a working way that comes to support of users and facilitate the understanding process of the stages listed above.

Key words: technical drawing, dimensioning, representation scale, format, CAD

Rezumat. Realizarea asistată de calculator, utilizând programul AutoCAD, ale planșelor de desen tehnic este un domeniu aparent pe deplin cunoscut de mulți utilizatori. Dar multitudinea de etape ce conduc, în cele din urmă la forma tipărită a unui desen tehnic, începând cu încărcarea și stabilirea proprietățile straturilor și terminând cu procesul de imprimare, face ca această acțiune să nu fie o sarcină ușoară. Din experiența practică, autorii cunosc faptul că dintre toate etapele necesare pentru a obține forma tipărită a unui desen, fazele care pot prezenta cele mai multe probleme sunt în număr a trei. Prima este cea care se referă la alegerea unui format standard pentru tipărire. Cea de a doua ia în considerare cazul în care utilizatorii nu pot reprezenta sau reprezintă în mod incorect, pe același format, mai multe reprezentări folosind scări diferite. În cele din urmă, a treia se referă la situația în care utilizatorii nu pot indica scara de reprezentare. Luând în considerare aceste inconveniente, autorii au dezvoltat un mod de lucru care vine în sprijinul utilizatorilor și facilitează procesul de înțelegere a etapelor enumerate mai sus.

Cuvinte cheie: desen tehnic, cotare, scară de reprezentare, format, CAD

¹"Gh. Asachi" Technical University of Iași, Romania

INTRODUCTION

Realisation assisted by computer, by using the computer program AutoCAD, of the technical drawings is an area where "everyone knows" because any graphical representation is essentially a conglomeration of line segments, rectangles, convex polygons, circles, arcs, ellipses and so on, and if the one who achieves the drawing knows both AutoCAD and the rules of the civil or industrial technical drawing, he may easily obtain the desired drawing.

It is known the fact that the achievement, by the classical method, using the technical drawing instruments (ruler, compass, pencil), of the technical drawings assume:

- choosing of a standard format of representation;
- establishment of one or more representation scales;
- reducing all distances to the appropriate scales;
- fitting to page of graphical representations;
- representation of the elements;
- achievement dimensioning.

Realisation assisted by computer, by using the computer program AutoCAD of the technical drawings, is totally different face to classical way and, if one of stages is not known or fully understand, the risk that the drawing be incorrectly is high.

From experience, the authors established that, during the time of technical drawing achievement, when AutoCAD is used, from the multitude of stages, the great majority of users:

- does not set correctly, depending on the used unit measure for the drawing, the unit measure for the standardised formats;
- does not fit correctly the graphical representation into printing format;
- cannot represent or represents incorrectly, on the same drawing, more graphical representations realised to different scales;
- cannot specify the adopted scale or scales.

Taking to account these inconvenient, the authors developed a strategy of work that comes to support the AutoCAD users and facilitate the understanding of stages listed above.

MATERIAL AND METHOD

The working mode proposed by the authors is designed as a flowchart and for the correct performance of all steps listed above AutoCAD users simply must carefully follow the logical scheme and to execute the steps outlined.

In order to verify the effectiveness of the logical scheme the authors have proposed to test it on several types of representations, both assembly drawings and details drawings, because in this way it is possible to cover a large range of representation scales (Table 1) and standard formats (Table 2). (Slonovschi A., Prună L., 2010, 2013).

Table 1

The representation scales commonly used and areas for their use

Areas of use of the representation scales	Commonly used representation scales
Construction details	1:1, 1:2, 1:5, 1:10, 1:20
Working drawings	1:20, 1:50, 1:100
Site plan	1:200, 1:500
Site layout plan	1:1000, 1:2000

Table 2

The standard layouts and theirs size according to adopted unit of measure, millimetre, centimetre, and meter

The standardized formats	Sizes		
	millimetre (mm)	centimetre (cm)	meter (m)
A ₄	210 x 297	21 x 29.7	0.21 x 0.297
A ₃	420 x 297	42 x 29.7	0.42 x 0.297
A ₂	594 x 420	59.4 x 42	0.594 x 0.42
A ₁	841 x 594	84.1 x 59.4	0.841 x 0.594
A ₀	1189 x 841	118.9 x 84.1	1.189 x 0.841

Testing was done on a group of 27 students.

Each student received the next two AutoCAD files (*.dwg):

- metal pole S₁; representation and basic details and capital.
- plan formwork - reinforcement plan GS₂.

The general characteristics of the two drawings are: all representations are made on 1:1 scale, there isn't any dimension placed on drawing and isn't established any standard format.

Regarding on the first drawing:

- was realized in millimetres;
- the representation of the pole does not change and does not scales;
- basic and capital details does not change but must be done to a bigger scale face to the existing one.

Regarding to the second drawing:

- was realized in centimetres;
- the representation of the beam does not change and does not scales;
- the sections through the beam does not change but must be represented to a bigger scale than the existing one.

The logical schema shown in figure 1 was made in such way that, in both cases, the students to resolve the next requirements:

- to establish, according to the units of measure used to the realization of the drawing, the units of measure for the standardized formats;
- to optimally fit, to a standardized format, the assembly, the metal pole S₁ and the plan formwork - reinforcement plan GS₂;
- to specify the adopted format;
- to specify the standardized representation scale that was adopted for the assembly;

to establish for details (basic details and capital and the sections through the beam) an optimum standardized scale;

- scaling the joining details with a value of scale chosen in such way that to the print, the details to be represented to the scale established to the previous step;
- to verify, in both situations, if the assembly and the details drawing are optimal framed to the chosen standardized format;
- in case that, the represented elements exceeded the chosen format, the students must adopt a new format or they must modify the representation scale of the details until all are fit within chosen format.

Because the logical schema is complex, the authors took the decision to note the boxes with numbers and letters and to explain separately the content of these.

Figure 1 represents the first part of logical schema through that the users are directed to individual branches in that all reports are done according to the adopted units of measure, millimeter, centimeter or meter.

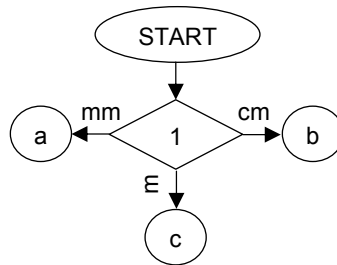


Fig. 1 - The first part of the logical schema

The components of this part of logical schema are:

- 1 – units of measure in that the drawing was made;
 - ✓ a – the branch in that all settings and values are according to millimetre;
 - ✓ b – the branch in that all settings and values are according to centimetre;
 - ✓ c – the branch in that all settings and values are according to meter.

If the branch "a" is continued the logical schema looks like in figure 2.

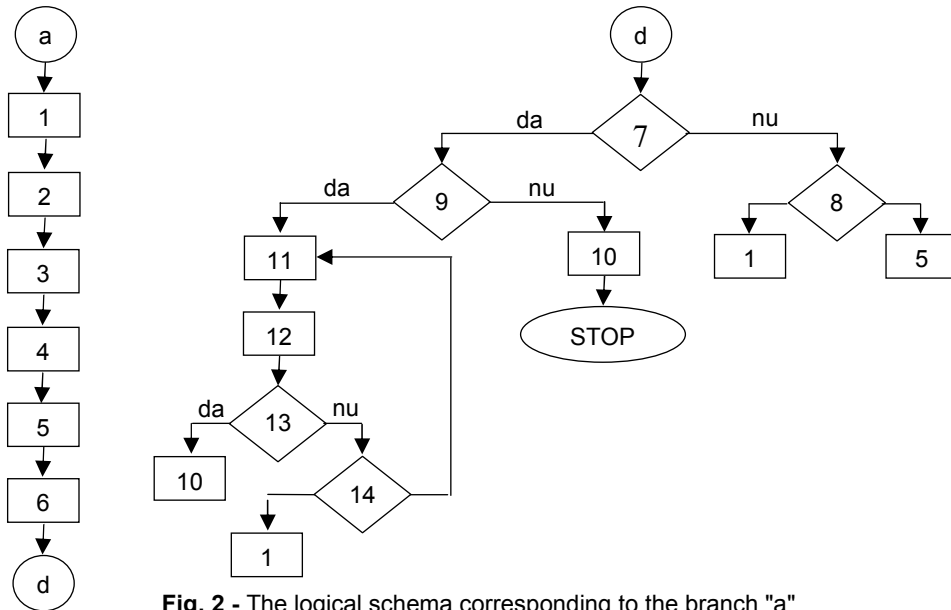


Fig. 2 - The logical schema corresponding to the branch "a"

The components from branch "a" of the logical schema are:

- 1 – one of formats A₄, A₃, A₂, A₁, A₀ are adopted;
- 2 – whatever format the title block has the sizes 185 x 40 (mm);
- 3 – the format and the title block are represented, using the command **RECTANGLE** with the sizes chosen previously;
- 4 – The representation scales can be reported to the values 1, 2, 5 or multiples with 10, above unit or below par of these numbers, thus:
 - ✓ 1:1;
 - ✓ 2:1, 5:1, 10:1;
 - ✓ 1:2, 1:5, 1:10;
 - ✓ 1:20, 1:50, 1:100, etc.
- 5 – will adopt a scale;
- 6 – the scale of the format and title block is modified using SCALE command, with a value inversely proportional of representation scale value, presented in step 3, thus:
 - ✓ if the adopted scale is 1:1 the scaling factor has value 1;
 - ✓ if the adopted scale is 1:n the scaling factor has value n;
 - ✓ if the adopted scale is n:1 the scaling factor has value 1/n.
- 7 – shall be determined whether the format adopted in step 1 and scaled in step 6 best fits in the representation received;
- 8 – it changes the adopted format in step 1 or the chosen scale in step 5;
- 9 – the drawing contains representations that could be realized at different scales?;
- 10 – it continues with the dimensions settings realization and with the dimensioning of the drawing;
- 11 – shall be determined a scale for realization of the details , according with table 3:

Table 3

The schema of determining of the representation scales

The representation scale of the assembly, adopted in step 5	The possible representation scale of the detail	Ratio of scales	The possible representation scale of the detail
1:100	1:50	$100 / 50 = 2$	2
	1:20	$100 / 20 = 5$	5
	1:10	$100 / 10 = 10$	10
1:50	1:20	$50 / 20 = 2.5$	2.5
	1:10	$50 / 10 = 5$	5
	1:5	$50 / 5 = 10$	10

- 12 – it scales detail/details with a value of the scale factor according to the ratio between the representation scale of the assembly and desired representation scale of detail/details;
- 13 – shall be determined if, both plane of assembly and detail/details scaled are optimally fit in the adopted format at step 1;
- 14 – it changes the representation format adopted at step 1 or the chosen representation scale of the detail at stage 11.

The logical schema corresponding to the branch "b" (drawing realized in centimetres) is different from the logical schema corresponding to the branch "a" only by the first two steps, because both the format sizes and the title block sizes must be

given in centimetres.

The logical schema corresponding to the branch "c" (drawing realized in meters) differs from the logical schema corresponding to the branch "a" only by the first two steps, because both the format sizes and title block sizes must be given in meter.

RESULTS AND DISCUSSIONS

As a result of the application by the students in the two groups of the logical schema, were consisted the following:

- a rate of 85.19% can follow the logical schema and:
 - ✓ can establish correctly the standardized printing format and the unit of measure used for specifying the sizes of the format;
 - ✓ can represent correctly, on the same drawing, multiple representations realized to different scales;
 - ✓ can indicate the representation scale or scales adopted in order to achieve the representations of the assembly and detail.
- a rate of 14.81% can follow the logical schema and:
 - ✓ can correctly establish the printing standardized format of the drawing and the unit of measure used for specify the sizes of the format;
 - ✓ can indicate the adopted scale in order to achieve the assembly representations;

The students from the second group (14,81%) cannot understand why is necessary to represent, on the same drawing, multiple realisations at different scales. From the discussions with them, the authors, have deduced that the students don't know the technical drawing rules regarding to the representation, on the same drawing, of multiple drawings realized at different scales and the advantages given by this type of representations.

Following a brief presentation of the rules and advantages and this small percentage of students was able to correctly represent, on the same drawing, multiple representations at different scales.

CONCLUSIONS

1. The logical scheme proposed by the authors is an indispensable tool for those who want to realize, correctly and rapidly, a series of stages that precede the printing process of any drawing;

2. The breakdown on the types of units of measure (millimetre, centimetre, and meter) presents the advantage that the logical schema can include a diverse array of types of representation and may be successfully used by any student or specialist that wishes to correctly print a technical drawing.

REFERENCES

1. **Slonovschi A., Prună, Antonescu I., 2010** – *Desen tehnic pentru construcții*. Ed. PIM, Iași, pp. 22, 27-32, 35-36.
2. **Slonovschi., A., Prună L., 2013** - *The International Conference on Engineering Graphic and Design*. Timișoara 13 - 15 June 2013, pp. 27-30.