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Means of Representing the Plumbing Installations Studied to Building Services Engineering Program

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Abstract: In this paper we propose to illustrate methods in which students attending undergraduate to building services engineering program are trained in order to make technical drawings for plumbing related projects.

Thus, in a first stage they learn to represent in 2D the plans and piping diagrams of the plumbing projects. One learns to represent also detailed technological drawings.

For the dimensioning calculus of the pipes is required axonometric representation of the plant (in isometric frontal oblique axonometry).

Further, undergraduates learn the 3D representation of the plants using the Allplan software. It is a narrative part containing the description of the methods, solutions proposed and experimental results.

Keywords: plumbing installations, technical drawing, ground floor, piping diagram.

1. INTRODUCTION

Graphical subjects are forms of communication between different categories of subjects involved in the information transmission process. Thus, there is the message (or information) that must flow between emitters - designers, inventors or teachers and receivers of information - performers, users, students or customers in general.

In higher technical education are studied, as subjects from this area, Descriptive geometry respectively Technical Drawing and Infographics.

Descriptive Geometry has the main purpose the understanding of the spatial forms (three-dimensional) and their transposition into two-dimensional plane, based on a geometric reasoning through various methods, mathematical founded.

Technical drawing represents graphical language of communication between different categories of professionals based on common norms and rules of representation of objects, systematized and unified through the standardization process.

In other words, the two subjects are in a relationship of interfering, of mutual conditioning and together they contribute to the learning of subjects with the abstractization. The students will imagine the forms in space and then their transposition in the two dimensional plan, they will develop the geometric reasoning and finally the ability to see into space.

Infographics represents an alternative of graphic expression of the technical concepts based on rules studied at the Technical Drawing subject via computer, by means of design software. As the market's demand and mobility are very high, it becomes very important for the students to acquire fundamental and classic reasoning, and then to possess the ability to adapt and assimilate new programs based on short-term intensive courses.

2. THE SYLLABUS OF THE GRAPHICAL SUBJECTS

For the students of Building Services Faculty within the Technical University of Cluj-Napoca, the graphics disciplines required for the preparation of drawings for the specialized projects are presented in the next table [3]:

Tabel 1

Subject	Semester	Number of classes/week		
		C	S	L
Technical Drawing and Infographics	1 and 2	-	-	2+2
AutoCAD	2	1	-	2
Allplan	3 and 4	-	-	2+2

The authors have proposed to present in a series of papers in the section „Educational methods in teaching graphic disciplines, E-learning”, the ways in which our students learn the representation of the specialized design. It should be noted that the specialization of Building Services is interdisciplinary, requiring knowledge of the industrial field (mechanical), civil engineering and obviously, instalations. But even the last one includes chapters having various areas, such as:

- Plumbing installations;
- Gas installations;
- Heating and refrigeration installations;
- Air-conditioning and ventilation installations;
- Electrical installations and automation.

Each of these chapters is characterized by conventional signs and specific rules, while respecting

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the general conventions. Among these conventions and rules to be followed, we would mention: the projection systems of views and sections, the representation scales, the types and thicknesses of lines, the conventional symbols used for various materials and objects, shading, elevations and dimensioning, etc.

Thus, in semesters 2 and 4 students learn specialized design, which then they deepen it within the disciplines provided with projects.

3. METHODS OF REPRESENTING THE PLUMBING INSTALLATIONS

In this paper the authors have presented the drawing pieces in the field of plumbing engineering, which the students of our specialization learn to represent it within the time allocated to graphical disciplines. Plumbing plants include cold water supply, hot water supply and sewerage. Those that are installed in buildings intended for beneficiaries demanding in terms of comfort are equipped with recirculation pipeline to provide hot water instantaneously to consumers. Of course, this involves additional costs, both in the execution phase as well in current exploitation. We opted for this version because we chose a bathroom from a residential building, equipped to the highest requirements.

3.1. THE TWO-DIMENSIONAL REPRESENTATION

The parts in a project can be drawn either classically – by drawing formats, by pencil and

various drawing tools, or with the help of a computer– by the use of special drawing editing programs. The drawing we propose in our topic was made with the help of AutoCAD [4]. As this software has a general character, that it is used by experts in all fields of engineering, the controls for drawing and editing will not be detailed in here.

The common drawings for the plumbing installation are the plans (drawn following the architectural plans of the building in question, at the 1:50 scale) and the diagram regarding the pipes.

In Fig. 1, we represented the ground floor plane of the plumbing installation.

The drawing stages are the following [2]:

- at a 1:50 scale, one represents the building including the related line thicknesses, that is thick continuous line noted C_2 (walls) and the thin continuous line C_3 (voids);
- plumbing fixture are then represented, at the drawing scale, with the conventional symbols, by a (C_2) line;
- it is represented the group of columns or plumbing knots with three circles, with very thick line noted C_1 ;
- the distribution of the pipelines, that is the supply with cold and warm (hot) water with a very thick continuous line C_1 ; the sewerage pipes are represented with 1.5 C_1 line, is the only type of installation that uses four thicknesses of lines;
- representation of service fittings on plumbing fixture and closing valves on pipelines;
- the plan is dimensioned so that all the components will be perfectly defined and according to the specific standards.

It is evident that the drawing representation was organised on layers.

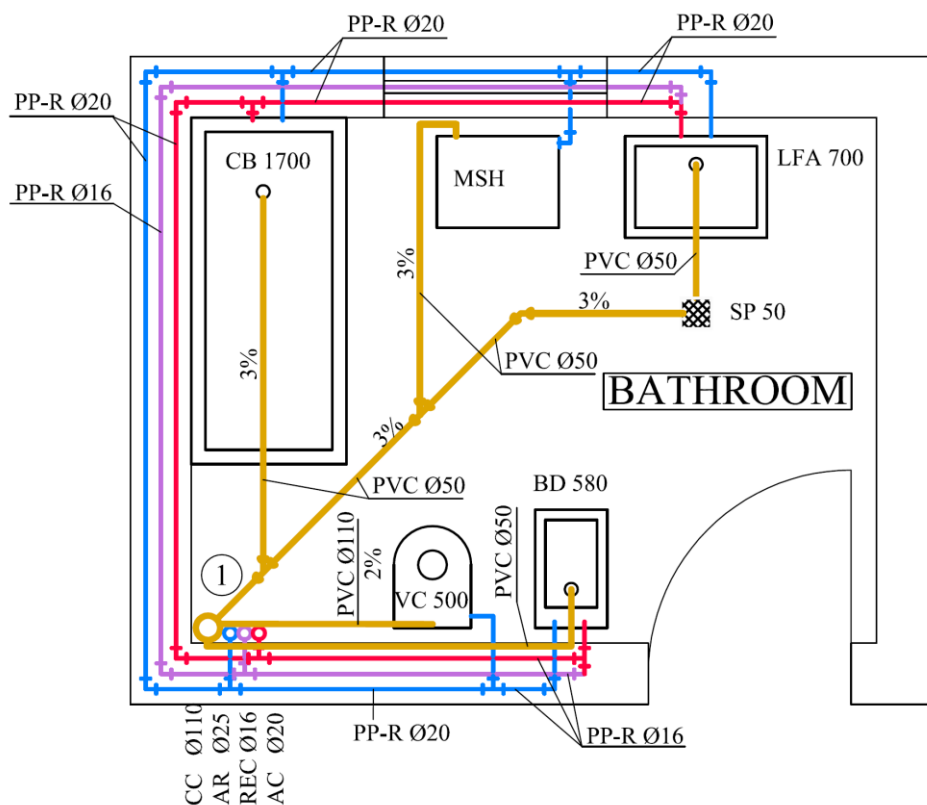


Fig.1. Ground floor.

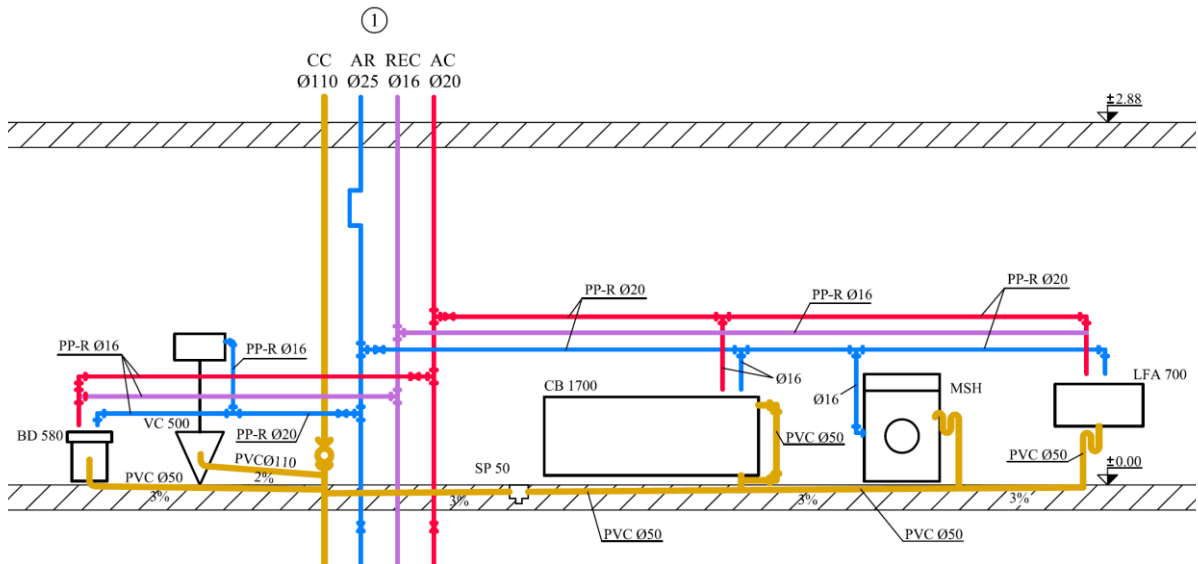


Fig.2. Piping diagram

In Fig. 2, the **diagram of the pipes** was represented, in fact, as a developed diagram of the entire installation, found by the orthogonal projection of the installation in a main vertical plane on which the walls of the building are brought into coincidence with the related installation; the plane scale is observed, the vertical dimensions and those of the sanitary appliances are respected, the only exception regards the derivations (connections) that are not represented according to the scale.

Projects also includes detailed drawings called execution details. This is draw on an convenient scale (1:50, 1:20, 1:10, 1:5, 1:2, 1:1) and can be prepared in the form of views or sections of a part of the installation. These are intended for execution and provide information about the position and the place of installation of some component parts of the plant, such as sanitary appliances, tanks, pumping stations, etc..

In Fig. 3 it is represented a detailed drawing for a toilet equipped with reservoir [2]. We notice that this includes the sanitary appliance, the connecting pipes, fittings, auxiliary and special components required for installation and operation.

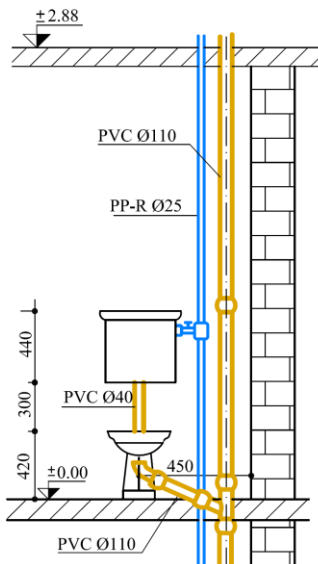


Fig.3. Detailed drawing for a toilet.

All the components elements are dimensioned properly to determine the object's and pipes position relative to the walls and to the floor, the type of object, respectively all the auxiliary pieces.

3.2.THE AXONOMETRIC REPRESENTATION

In the piping diagram within the interior plumbing installation, the columns stop just below ground level without drawing the distribution pipes in the basement. This is because many columns are identical for some buildings with large horizontal extension. Thus, they are represented only once and through their numbering (the columns or group of columns) they find their correspondent in current plans, including basement plan.

But to represent spatial all the elements drawn in the plans of all levels, basement and piping diagram, it is used the frontal oblique isometric axonometric projection, also called Cavalier perspective.

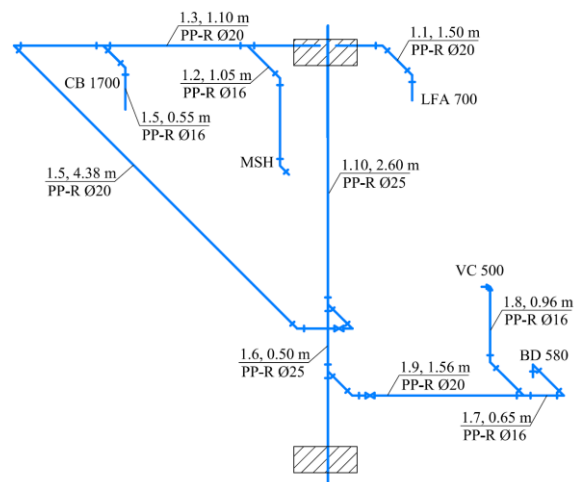


Fig. 4. Axonometric representation.

In everyday language, these representations are called isometric diagrams. They are a real support in the management of pipes and networks dimensioning calculation. It also allow reading the dimensions of

the component elements during the assembly execution of the plant and, in addition, give an overall picture of the installation.

In general, isometric diagrams are drawn separately for cold water, hot water and sewerage, because otherwise it may cause overlaps (of representation) of the columns, which could determine confusion. In Figure 4 it is represented the isometric diagram of the cold water supply system for the corresponding part of the building for which we organized the study.

3.3. THE THREE-DIMENSIONAL REPRESENTATION

In order to make the representation of the plumbing installation for the part proposed with the ALLPLAN software, the steps to be followed will be similarly with the stages that we presented to the previous paragraph.

As the representation in Allplan is more complex and is a special program for Civil and Building Services Engineering fields, the authors intend to detail and exemplify the most important steps [5].

In order to draw an ALLPAN representation of sanitary installations in the apartment, the following steps will be followed:

- 1:50 scale representation of the building in the architecture mode;
- arrangement of the sanitary appliances;
- representation of cold water pipes, hot water and recirculation pipes, followed by connection of appliances;
- representation of sewer pipes and connection of appliances;
- calculation of pipes dimensioning;
- dimensioning of all the installation elements according to results found earlier.

Considering that representation in ALLPLAN is complex, next we will take each of the steps mentioned above and we will present them in detail by examples.

The design of the ground floor plane starts with representing the axes by using the Orthogonal Axes button found in General Module / Civil Engineering extended module (Fig.5.a.). Masonry elements will be drawn by choosing different wall types from Architecture / Basics: Walls, Openings (Fig.5.b.). The wall openings are represented in a similar way, by choosing from one of the Doors (Fig.5.c.) or Windows (Fig.5.d.) icons, found in the same menu.

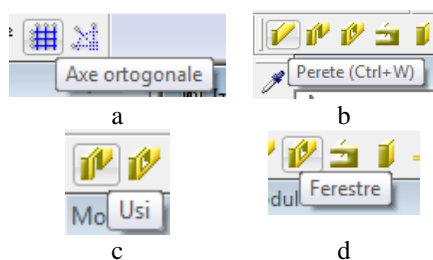


Fig.5 Allplan icons

Given that the software provides its own installation and building dimensioning, each new

element must be properly defined. Therefore, walls must be defined by height, width and number of layers (brick, thermal insulation). Windows are defined by height, width and height of window sill. For doors you need to determine height, width of door opening and number of door leaves.

Once the basic building elements are drawn, the next step is placing sanitary appliances from *Installations in Buildings / Sanitary Installations*. First the Placing of Sanitary Appliances toolbar is activated (Fig.6.), followed by choosing *Symbol Catalogue* and *3D Architecture* from *Catalogue Selection*. At this point, sanitary appliances for bathroom and kitchen are selected (Fig.7). Here we have an example of a bathroom equipped with sink, bathtub, toilet, bidet, floor drain and washing machine. For the kitchen we chose a sink and a dishwasher.

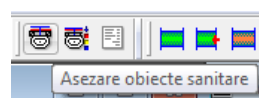


Fig.6 Placing of sanitary appliances toolbar

As with walls, windows and doors, Allplan also provides dimensioning for pipes, which in turn must be properly defined by using *Define Sanitary Items* (Fig. 8). Selecting the item we want to define opens the window *Sanitary Equipment* (Fig. 9) where we choose from different types of objects. Here we can define pressure, flow, diameter and junction points. This step is repeated for each sanitary item.

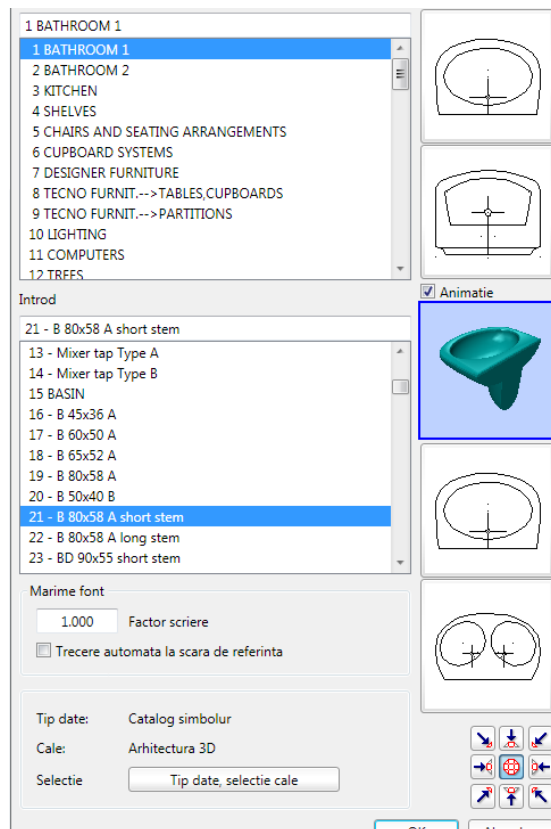


Fig.7 Window for choosing sanitary appliances

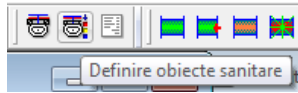


Fig.8 Define Sanitary Item toolbar

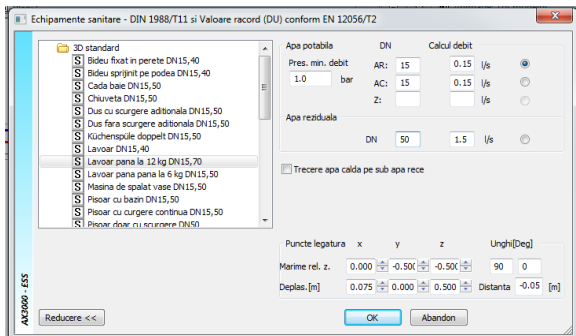


Fig.9 Sanitary Equipment Window

The next step consists of defining the elements needed for dimensioning the system, by using *Installations in Building / Dimensioning of Sanitary Items*. We start by using the *3D Parallel Polylines* toolbar in order to trace the cold water, hot water and return pipes (Fig.10).

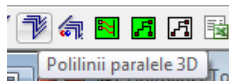


Fig.10.3D Parallel Polylines

The sanitary appliances are connected to the pipes by using the *Cold Water/Hot Water Sanitary Junctions* toolbar (Fig.11). The appliance is selected first and then the hot water and cold water pipes are selected accordingly. This operation is repeated for all sanitary appliances.

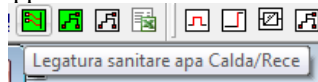


Fig.11 Sanitary Junctions toolbar

The elements necessary for dimensioning cold water and hot water pipes are defined by using the *Sanitary Items Dimensioning + Lists* (Fig. 12). This will result in dimensioning calculations for the selected area. The results are generated in an Excel file which also includes an estimate on necessary materials.



Fig.12 Sanitary Items dimensioning toolbar

For the return pipe we must define the junction point with the hot water pipe, by using the *Return pipe junction point* toolbar (Fig.13) from *Installations in Buildings / Return pipe dimensioning*.

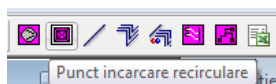


Fig.13 Return pipe junction point toolbar

To connect the return pipe to the junction point we use the *Return Pipe Junction* toolbar (see Fig. 14.a)

and then we can move on to dimensioning the return pipes by using the *Return Pipe Dimensioning + Lists* toolbar (Fig.14.b), which generates an Excel file where we find the results and the estimate of necessary materials.

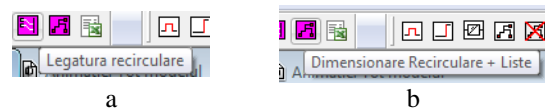


Fig.14 Return pipe junction and dimensioning toolbars

Once the cold water, hot water and return pipes dimensioning is complete in plane, in isometric view and also in animation, the pipes are no longer represented as lines, but as a real pipes.

The last step consists of tracing and dimensioning the sewer pipe in *Installations in Buildings / Sewer Dimensioning*.

The sewer pipe is traced by using the *3D Parallel Polylines* toolbar (Fig.15.a). Because curbs and intersections on sewer pipes cannot be made in a right angle, we need to represent them as chamfered by using the toolbars presented in Fig.15.b and Fig.15.c.

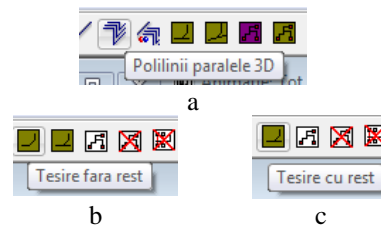


Fig.15 Sewer toolbar icons

The sanitary appliances are connected to the sewer by using the following toolbars: *Lower sewer junction* (Fig.16.a) for the bathtub and floor drain and *Back sewer junction* (Fig.16.b) for all the other sanitary appliances.

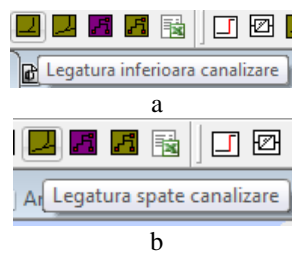


Fig.16 Sewer toolbars

Two different toolbars are used for dimensioning the sewer pipe: *Slope Sewer Dimensioning* for horizontal pipes (Fig.17.a) and *Sewer Dimensioning* for vertical pipes (Fig.17.b).

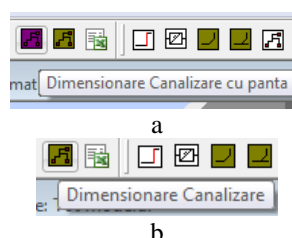


Fig.17 Sewer pipe dimensioning toolbars

A general image of the stages passed through can be seen in the following print screens (Fig. 18).

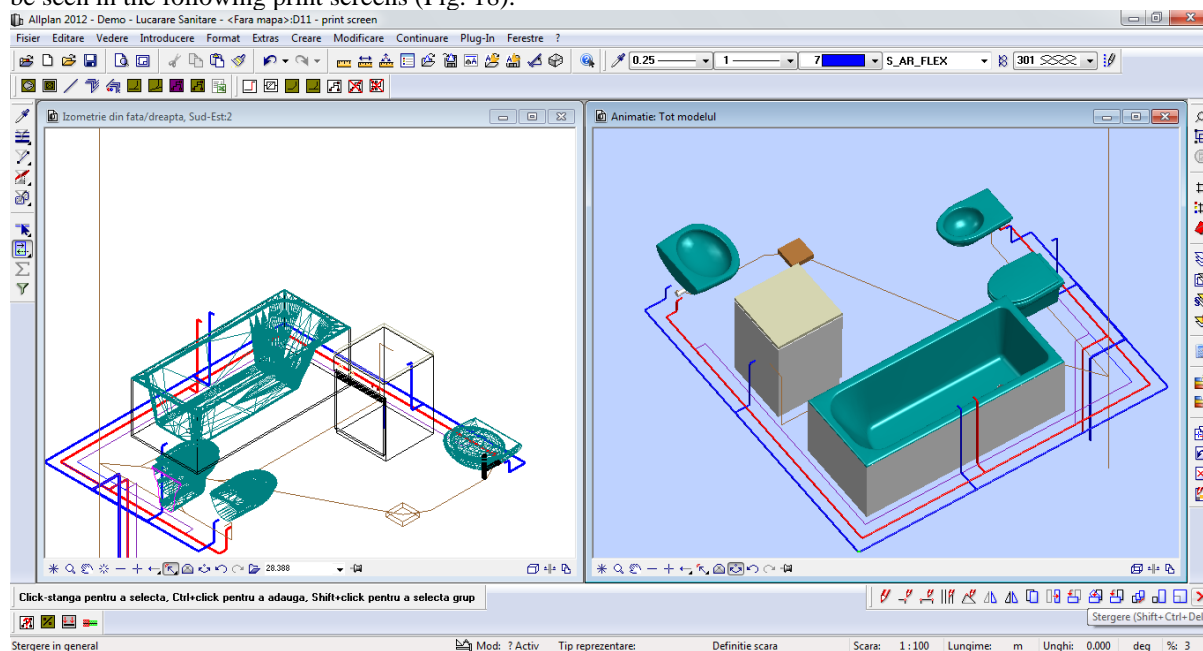


Fig.18. Overview of the bathroom

3. CONCLUSIONS

The graphical subjects contribute to forming and developing the undergraduates' space vision and capacity of perceiving the double relationship between the representation in plane (2D) and in space (3D). The opinion of the experts in graphical engineering is that all beginners in engineering should start with manual drawing, learning standards norms so that they can learn and develop their way of thinking and perceiving notions and concepts in a proper technical manner, followed by computer aided design, with specialized software. In the Faculty of Building Services emphasis is put on AutoCad and AllPlan.

We try to find and develop the communication and conveyance methods of the information to the students, in accordance with the fundamentals of the quality standard ISO 9001, applied to higher education. Standard ISO 9001 was adopted in 2008 and it contains the requirements related to a general System of Quality Management [6]. This standard is applied to education too, if we consider that the undergraduate is the customer of the educational institution for whom the quality of the services provided should comply with the European quality assurance systems.

The Bologna process specifies and imposes the European quality standards for higher education and establishes a set of reforms that tend to focus education on student's needs, in Europe [1].

This process aims at putting closer the syllabi under study in various universities from various countries so that the transfer of credits between institutions affiliated to the Bologna process actually operates. Not last, the Bologna process also proposes a mobility of subjects and curricula in tight connection with the economic needs of markets.

Educational institutions should comply with quality standards in so far curricula are concerned, should develop and implement strategies envisaging the permanent improvement of quality.

REFERENCES

- [1] Mârza, C., Iacob, G., Representation methods from the curricular area of descriptive geometry, put in agreement with the law for quality assurance in higher education, The International Scientific Conference for Geometry and Engineering Graphics "moNGeometrija2010", Belgrad, Serbia, ISBN 978-86-7924-040-8.
- [2] Mârza, C., Corsiuc, G., (2011), Desen tehnic si infografica – Specializarea Instalatii pentru Constructii, Editura U.T.PRESS Cluj-Napoca, ISBN 978-973-662-665-4.
- [3] Mârza, C., Fărcaș, A., Corsiu, G., Methods of teaching graphical subjects to building services engineering students, Journal of Industrial Design and Engineering Graphics, Nr.7, 2012, Ed. SORGING, ISSN 1843 – 3766
- [4] Simion I., AutoCAD 2005 for engineers, TEORA USA Publishing House, ISBN 1-59496-033-X 2005, New York.
- [5] <http://documentatie.nemetschek.ro>
- [6] SR EN ISO 9001:2008, System of Quality Management.