Using the Capabilities of the AutoCAD Program to Solve Metric and Position Issues

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Abstract: The article proposes to "compare" the solution of metric and positional problems in engineering graphics, that is, to perform it in practice with the help of computer programs after doing it manually based on theoretical knowledge. Theoretical knowledge teaches how to read drawings, how to imagine objects spatially depending on their representation, what operations are necessary to solve the problem, and introduces the laws and rules. Computer graphic programs, on the other hand, ensure that the drawings are done quickly, cleanly and accurately.

1. Introduction

In recent years, the introduction of new educational technologies into all areas of education requires effective use of computer technologies. In this regard, great importance is given to teaching how to perform programming, projecting, and reworking operations. Educational technology solutions have been carefully tested to determine their efficacy in improving teaching and learning paradigms [1]. Artificial Intelligence in Education (AIEd) is a fast-expanding sector of educational technology that provides tailored learning experiences [2]. As science and technology evolve, big data and wireless communication technologies are increasingly being integrated into education [3]. Furthermore, the post-Covid-19 age has seen the incorporation of numerous educational technologies like as computers, smart boards, projectors, tablets or smartphones, and digital cameras to aid in teaching and learning [4].

Furthermore, elementary school educational programs stress the development of algorithmic and programming thinking in order to improve cognitive processes among young children [5]. The integration of robotics programming into educational institutions, such as in Malaysia, emphasizes the necessity of adopting current technology to improve learning experiences [6].

The use of AutoCAD, a popular software tool for computer-aided design, has been extensively acknowledged in a variety of educational contexts for improving technical abilities, design comprehension, and streamlining drafting and modeling processes [7]. Studies have indicated that training programs focused at developing students' knowledge and abilities using AutoCAD are beneficial in improving competences linked to higher education majors [8]. Furthermore, the usage of AutoCAD has helped to improve the competency of vocational school professors and students, with more than

90% of participants able to efficiently use the program following training sessions [9].

AutoCAD has also been used in professional settings, such as designing microfluidic cartridges for protein monitoring in biopharmaceutical manufacturing operations [10]. Furthermore, the program has been integrated into the educational process to improve students' learning experiences in sectors like as engineering and architecture, where it is frequently used for 2D sketching and 3D modeling [11]. Furthermore, the use of AutoCAD in electrical installation projects has been compared to Building Information Modeling (BIM) software, demonstrating its importance in design processes [12].

The authors of this article propose to "compare" the solution of metric and positional problems in engineering graphics, that is, to perform it in practice with the help of computer programs after doing it manually based on theoretical knowledge. Theoretical knowledge teaches how to read drawings, how to imagine objects spatially depending on their representation, what operations are necessary to solve the problem, and introduces the laws and rules. Computer graphic programs, on the other hand, ensure that the drawings are done quickly, cleanly and accurately [13]. Computer graphic systems, such as AutoCAD, are critical tools in educational contexts for teaching drawing and engineering graphics. These tools allow students to generate geometric objects, execute volumetric modeling, use color schemes, and properly represent dimensions, according to Rustamov [14]. The use of AutoCAD, along with other graphic tools, is critical for improving future professionals' graphic literacy, allowing them to learn design processes and gain field competence [15]. According to research, engineering and architecture students that use AutoCAD produce precise and thorough drawings, which aids in the visualization and transmission of ideas [7].

2. Method

This study article takes a practical approach to investigating the use of the AutoCAD application in resolving metric and positional challenges in design and engineering projects. The process entails collecting relevant data on these difficulties from various sources. Researchers receive extensive training in AutoCAD to become acquainted with its features and functions. Real-world case studies that demonstrate metric and positional issues are chosen and evaluated with AutoCAD software. The success of AutoCAD solutions in resolving these concerns is assessed using metrics including as accuracy and time efficiency. Furthermore, AutoCAD's capabilities are contrasted to other methodologies or software solutions typically utilized in the business. The study's analytical approach attempts to show how AutoCAD may effectively solve metric and positional difficulties in design and engineering applications.

3. Results and Discussion

3.1. Draw the horizontal and frontal projections of the plane P given by $\triangle ABC$

Given: P ($\triangle$ ABC)

Find: P (PH, PV) -?

The algorithm for performing the epure is as follows.

1) The straight-line AB (AB) intersects with the plane of horizontal projections (H) and produces the point M (M_H). The point M_H is the horizontal trace of the straight-line AB, mH is its horizontal projection, and m'H is its frontal projection.

2) As a result of the intersection of the straight-line AB (AB) with the plane of frontal projections (V), it forms the point N (N_v). Point N_v is the frontal trace of the straight-line AB, n_v is the horizontal projection of the trace, and n'v is the frontal projection of the trace [16] (Figure 1).
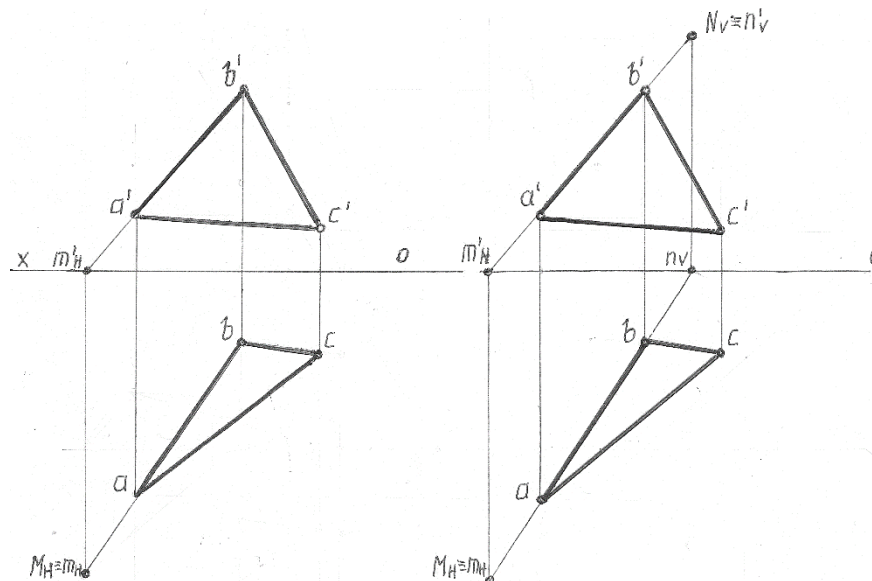
Figure 1. Result

3) As a result of the intersection of the straight-line BC (BC) with the plane of horizontal projections (H), it forms the point M_1 (M_{1H}). The point M_{1H} is the horizontal trace of the straight-line BC, and m_{1H}, $m_{1'H}$ are the horizontal and frontal projections of the trace.

4) $\triangle ABC$ is the horizontal trace of AB and BC, connecting the points M_H and M_{1H}, we form the horizontal trace (P_H) of the plane by connecting M_H and M_{1H}.

5) We create the point P_x, the frontal trace of the straight line AB ($N_V \cup N_V$), the frontal trace of the plane [17,18] (Figure 2)
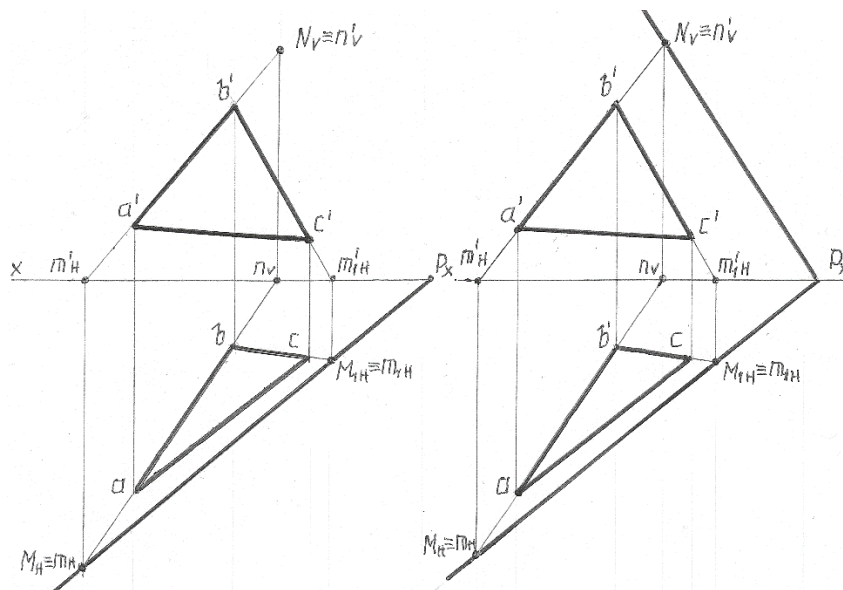

Figure 2. Result

1)   (AB) ∩ H = M_H (m_H, m'_H)
2)   (AB) ∩ V = N_V (nV, $n'v$)
3)   (BC) ∩ H = M_{1H} (m_{1H}, $m_1'_H$)

4) $M_H \cup M_{1H} = P_H$
5) $P_H \cap [OX) = P_X$
6) $P_X \cup N_V = P_V$

3.2. Make horizontal and frontal traces of the plane given by the triangle ABC

Using the paper format created to solve this problem in the AutoCAD program, we place the horizontal and frontal projections of the triangle using absolute or relative coordinates in this format.

First of all, before entering these coordinates, it is necessary to determine the position of the X coordinate axis. This problem can also be solved in several ways by entering the coordinates of the point in the command window, connecting it to the grid and steps, and directly using the mouse [19,20].

Issue - Enter the coordinates of the above-mentioned A4 format and the main frame lines using the Draw - Line command. Load the Draw - Point - Multiple point command and enter the coordinates of consecutive points from the command window. After entering the coordinates of each point, confirm the command with ENTER. (The shape and size of the point can be specified in a special window that opens using the Format - Point Style command in the main MENU).

```
Command: _point
Current point modes:  PDMODE=3  PDSIZE=5.0000
Specify a point: 70,110
Confirm the command.
Command: _point
Current point modes:  PDMODE=3  PDSIZE=5.0000
Specify a point: 240,210
```

Use the Draw - Line command to connect the two points with the cursor. (For this, enter the Object snap – Snap settings linking mode, select the Node section, move the cursor to the point, the cursor will connect to the point, confirm the command by clicking the right mouse button. Repeat this action by moving to the second point) Coordinates of triangular ABS as follows:

A (65,43,30), B(40,12,60), S(0,15,14)
We enter these dimensions into the Auto CAD system as relative or absolute coordinates.

```
Enter the absolute coordinates of the frontal projection of the triangle:
Command: LINE Specify first point: 125,140
Specify next point or [Undo]: 150,170
Specify next point or [Undo]: 190,124
Specify next point or [Close/Undo]: c
Enter the absolute coordinates of the horizontal projection of the triangle:
Command:  LINE Specify first point: 125,67
Specify next point or [Undo]: 150,98
Specify next point or [Undo]: 190,95
Specify next point or [Close/Undo]: c
```

For example: In the same way, the horizontal projection of the triangle can be entered through relative coordinates:

```
Command: Line Specify first point: 150,98
Specify next point or [Undo]: @40,-3
Specify next point or [Undo]: @-65,-28
```

Specify next point or [Close/Undo]: c

This issue can be entered through points using the Line command and the Multiplie point command. In this case, it can also be done through the mode of connecting a line to a point. The position of the dots is visible in this diagram. Another way is to move the points along the x,y,z axes using the Modify - Move command by placing the points directly at the place assumed to be the origin of the coordinate. This method is the most convenient method. Place the point at the coordinate origin. Load the Modify – Move command, point to the point, and enter 105 on the X-axis (from the command window).

Command: MOVE 1 found
Specify base point or [Displacement] <Displacement>: Specify second point or
<use first point as displacement>: 105
Redefine the point in the same manner and enter 43 on the U-axis
Command: Specify opposite corner:
Command: m MOVE 1 found
Specify base point or [Displacement] <Displacement>: Specify second point or
<use first point as displacement>: 43

Load the Modify – Copy command, point to the point with the mouse, right-click, move up and enter 73. Other points can be moved in the same way. Connect the points using the cursor using the Draw-Line command 7,8.
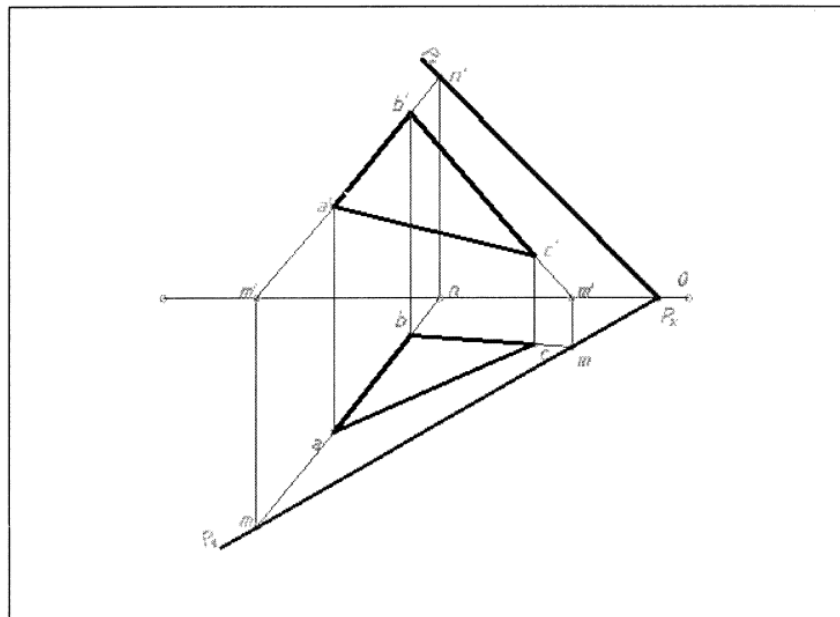

Figure 3. Result

A line should be drawn through the projections of the resulting triangle until it meets the X axis. To do this, load the Draw - Line command, put the cursor on the point assumed to be frontal a1, and press the SHIFT key to enter the connection mode, load the Extension command from it. Point to the second point b with the cursor. Show a line continuation without confirming the command. The continuation of the line is indicated by a dashed line. Confirm the command by passing the line through the X-axis.
Download the Modify - Trim command and click the right mouse button on the excess part of the resulting line. Cut off the excess part of the line.
Download the Draw - Line command from the upper m1 point and draw a straight line perpendicular to the X axis that crosses the line from the horizontal projection of the

side ab. Trim off excess lines by loading the Modify - Trim command.

Draw lines from the other sides of the triangles in the same order and find the points MN. Join the two found horizontal tracks by loading the Draw – Line command. now, to extend this line to the X coordinate axis, load the Modify - Extend command, click the right mouse button, indicate the part of the line to be extended with the cursor, click the left mouse button, and confirm the command. The line extends to the X-axis. Connect the points Rx and n1 using the Line command [21,22].

4. Conclusion

To summarize, the current study has effectively proved the usefulness of using the AutoCAD application to handle metric and positional issues inherent in the field of "Descriptive Geometry and Engineering Graphics." The study revealed the practical application abilities gained in this sector by focusing on spatial plane building traces. By efficiently utilizing AutoCAD's capabilities, the research not only attained its goal of fixing metric and positional concerns, but also contributed to the advancement of understanding in the field. The findings highlight the need of incorporating technical solutions like AutoCAD into Descriptive Geometry and Engineering Graphics curriculum. Moving forward, increased research and application of software products such as AutoCAD hold tremendous promise for enhancing instructional techniques and improving proficiency in spatial visualization and problem-solving skills among engineering and design students.

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