



Applying construction and descriptive geometry principles through CAD: Experiments with solid works

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Abstract

It is generally acknowledged that computer-aided drafting (CAD) has rendered traditional construction and descriptive geometry methods obsolete. This two-part study experimented with SolidWorks in these two geometric areas by investigating assignments submitted by first-year engineering students at the Botswana International University of Science and Technology. The first part, conducted in 2017, used a simple geometric shape to train a cohort of 178 students on how SolidWorks could be used to mimic traditional construction geometry methods to model the shape. Participants were then assigned more complex geometries to apply appropriate SolidWorks methods to mimic the construction geometry methods of the assigned shapes. The students worked in groups of at least five members and completed the assignments in a three-hour lab session. The second part, conducted in 2024, addressed the visualization dilemma associated with the passive, teacher-centered methods used in demonstrating the descriptive geometry rabatment process. Another cohort of 557 students, working in groups of at least six members, developed SolidWorks models to demonstrate the process. This cohort was given over 12-hour lab sessions to complete the task. The results from the construction geometry experiments show that participants struggled to mimic traditional drawing techniques in SolidWorks, while the descriptive geometry cohort developed meaningful SolidWorks rabatment process models. These two CAD-based approaches are pedagogically important because, in the first part, traditional construction geometry was extended into platforms that support e-learning, while in the second part, a flipped learning approach to descriptive geometry was introduced.

Keywords: CAD, Construction geometry, Descriptive geometry, Interactive learning, SolidWorks.

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Contribution of this paper to the literature

Current computer-assisted construction geometry studies compare the performance of learners taught using traditional techniques to those taught using CAD applications. This study extends previous research by involving learners in mimicking traditional techniques within SolidWorks. In descriptive geometry, no prior study has illustrated the rabatment process using SolidWorks or other CAD applications.

1. Introduction

The importance of both descriptive and construction geometries is well documented in history. For instance, descriptive geometry was once a protected military secret (Lawrence, 2019), while geometrical construction used to be a major requirement for entry into top universities worldwide (Pratt & Ainley, 1997). However, with the emergence of CAD, these geometric principles have become obsolete (Bokan, Ljucovic, & Vukmirovic, 2009). In fact, CAD has not only caused a decline in construction and descriptive geometry but also affected the broader field of engineering graphics. For example, a study conducted in South Africa reported that of all the chemical engineering universities that previously offered technical engineering drawings, only 33% continued to do so in 2016 (Kotole 2016). A recent study in Poland observed a concerning trend in the teaching of descriptive geometry, with reductions in teaching hours and even complete elimination in favor of computer-aided design (Niedziela, Chomicka, & Malewczyk, 2024). This decline in the relevance of construction and descriptive geometry, along with technical drawings in general, contrasts with developments in other areas of knowledge. For instance, in the field of algorithms, computer-aided geometric design and the analysis of complex algorithms are collectively referred to as computational geometry (Guibas & Stolfi, 1989). In the Euclidean branch of mathematics, significant advancements in the application of computer programs for creating and manipulating geometry have led to the development of dynamic geometry. Mottola and Cocconcelli (2024) provide a historical account of ancient geometric principles such as nomographs, their golden age, subsequent decline, and how their valuable aspects could be preserved through modern computer graphics.

Therefore, in the same way that geometers in other fields have extended old concepts using computers, the modern engineering geometer also should find ways to integrate traditional descriptive geometry into modern CAD systems. This is especially important because the traditional construction and descriptive geometry approaches impart spatial visualization skills to learners in a way that CAD does not. The purpose of this paper is thus to contribute towards the modernization of construction and projection geometry. The basic working principles of these geometries considered in this study are briefly explained in the next two subsections to provide context for this investigation. The rich, solid, and artful theory of the traditional approach is also expounded in the subsections to highlight what the engineering draftsman stands to lose if traditional methods were to be replaced by CAD.

1.1. Constructive Geometry

What is construction geometry? Construction geometry, as engaged by ancient geometers, was primarily concerned with the problem of constructing geometric elements given two points using only an unmarked compass and an unmarked straightedge. They realized, in one instance, that given two points, they could draw a line passing through these points. They also understood that it was possible to draw a line passing through one of the points with the other point as the center (Crabtree, 2007). However, this does not fully define what construction geometry is. It is often best introduced through an example (Davis, 2002). A typical simple geometrically constructible model (i.e., a model fully constructible using only a straightedge and a compass) is illustrated in Figure 1. To build this model, the arcs 1, 3, 5, 6, 7, and 8 are fully constructible using only a compass, while lines 2 and 4 are fully constructible using only a straightedge. The combination of these two drafting instruments results in a geometry where features transition seamlessly from one to the other at exact start and end points. This concept is referred to by (Leopold, 2006) using the terms harmony, symmetry, and congruence to describe the joining of different or opposing features to form a cohesive whole. Leopold later summarizes this as "the union of antagonisms" (Leopold, 2006). In traditional construction geometry, achieving this using only a compass and an unmarked straightedge requires adherence to carefully developed drawing techniques refined over many years of meticulous draftsmanship. These techniques form part of a rich repository of intellectual inquiry, including algorithms, axioms, theorems, lemmas, and corollaries of engineering graphics. Modern geometers recognize the importance of preserving these methods, especially as CAD applications operate on fundamentally different geometric platforms. Therefore, any effort to replicate these techniques within modern CAD environments is a valuable and necessary pursuit.

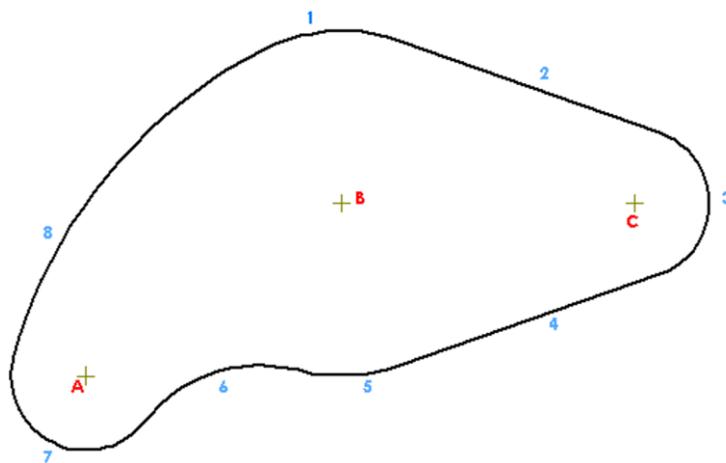


Figure 1. Demonstration of geometric construction principles.

1.2. Projective Geometry

On the other hand, descriptive geometry is a planar projection method involving two basic components: a geometric entity in space whose views (e.g., front or top view) are desired, and at least two planes on which the views of the entity are to be formed. At the most basic level, the form, position, and configuration of the resulting views depend on the spatial relationship between the figure and the planes. Different permutations therefore, arise according to the terminology chosen to express the spatial relationship. Typically, descriptive geometry problems are always given in text form (e.g., a point a is in the first quadrant, and it is $[x]$ mm in front of the vertical plane [VP] and $[y]$ mm above the horizontal plane [HP]). Figure 2 illustrates four simple cases, in which the text format is first translated into the XY coordinate system to locate the given geometrical entity in space. The front view (aF) and top view (aT) of the entity result from projectors from the entity striking the XY plane (i.e., VP and HP), as illustrated, with the Y (HP) axis always rotated clockwise to align with the X (VP) axis. Finally, the views are displayed planarly as illustrated in the shaded rectangles. Figure 2(e) illustrates the process using a line. In this 3D example, a line $[mn]$ is in the fourth quadrant. Dotted lines show traces from the line to where its endpoints strike the planes, and arcs show the clockwise rotation of the top view as the horizontal plane (HP) is made coplanar with the vertical plane (VP), resulting in the accompanying coplanar rectangular view.

The factors mentioned above namely, the various location terminologies of entities in space, the mapping of views onto planes, and the rotation of the horizontal plane to align with the vertical plane can cause visualization problems for beginners when combined in the normal course of descriptive geometry. This issue is referred to as the 2D-3D visualization dilemma, as described by (Martín & Rubio, 2009). To address these challenges, new methods need to be developed, particularly using AutoCAD. This has led to the creation of several computer-aided geometric techniques from multiple viewpoints, which will be discussed in the literature review.

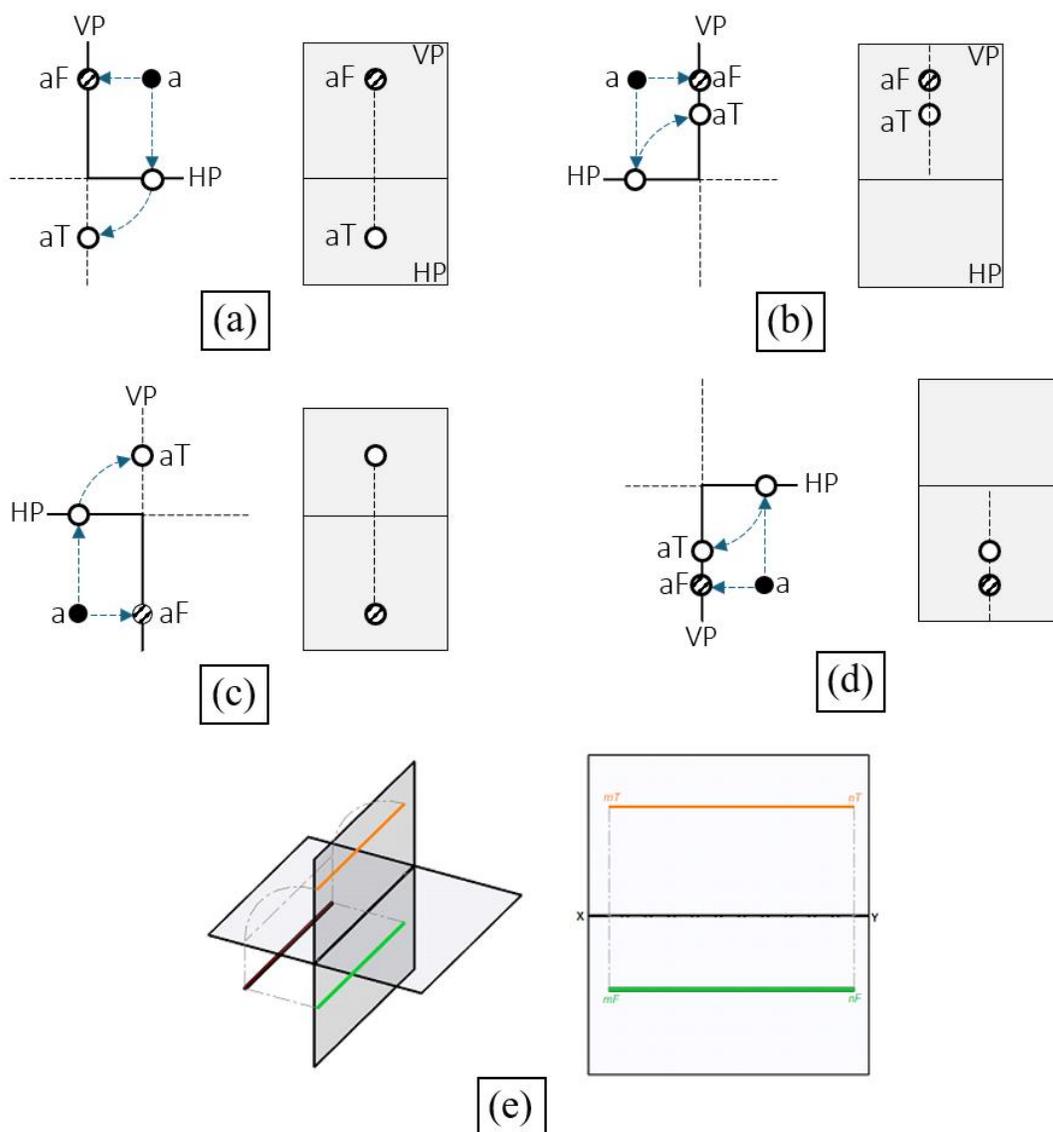


Figure 2. Typical graphical descriptive geometry representations showing both the XY coordinate system and their coplanar equivalents for the following text formations: (a) First quadrant (in front of VP and above HP), (b) Second quadrant (behind VP and above HP), (c) Third quadrant (behind VP and below HP), (d) Fourth quadrant (in front of VP and below HP), and (e) a line mn in the third quadrant, located y mm behind the VP, x mm below the HP, and parallel to both the VP and HP.

2. Literature Review

Medieval masons attached a string to a peg and rotated the loose end to draw circles (Shelby, 1965) as a precursor to the modern compass, which is the primary tool in construction geometry. The medieval period is generally understood to have occurred between 1100 and 1500 (Robinson, 1984). Descriptive geometry, on the other hand, is popularly associated with the works of Gaspard Monge in 1794, although (Migliari, 2012) traces its origins to the works of Piero Della Francesca in 1480. Clearly, from the foregoing historical accounts, both geometries have existed for many years, during which significant changes have occurred. For instance, circles are no longer drawn using strings on pegs, nor do geometers still employ the descriptive geometry techniques of the 18th century. More importantly, the invention and subsequent exclusive use of electronic systems capable of supporting graphical

representations have brought about epochal changes to both geometries (Migliari, 2012). These developments are briefly reviewed in the following two subsections, although many comprehensive reviews exist.

2.1. Construction Geometry

Research on construction geometry in the context of computers spans several topics. One of the foundational theoretical concepts is the proof by Alex and Mutembei (2017) demonstrating that the trisection of an arbitrary angle cannot be achieved using only a traditional compass and straightedge. This work utilized GeoGebra software to visualize the results. However, it does not involve the use of CAD software, nor does it include active participation from learners.

The series of geometric supposers by Schwartz (1989) concerning triangles, quadrilaterals, and circles is next in the relevance scale. These geometric supposers are computer software environments specifically designed for mathematics classrooms to promote conjecture and creativity among students and teachers. However, it is important to note that geometric supposers are prescriptive tools and are not generated by the learners themselves.

The work of Migliari (2012) is that of a geometer troubled by the obsolescence of the field, yet he sees salvation in the use of CAD. However, the authors did not propose any CAD-based approach to counteract the decline. Schmidt (2013) takes the stage in the 21st-century digital era to urge modern design engineers to sketch (i.e., use a straightedge and compass) and maintain design journals. Nonetheless, he does not provide guidance on how such sketching can be facilitated amid the intense competition from CAD.

Lastly, on the practical research dimension, Martín-Gutiérrez, Gil, Contero, and Saorín (2013) used a pilot study that compared conventionally taught descriptive geometry with a method that employed a dynamic descriptive geometry tool called Diedro-3D. Although this was a commendable initiative with promising prospects for its developer, it lacks popularity, likely due to its proprietary nature and its confinement to the Spanish-speaking world. In their seminal work, Chen, Lee, Lei, Tso, and Lin (2017) compared the learning effectiveness of using a *smart* PowerPoint slides approach versus a traditional instructor-based construction and explanation approach in teaching the principles of bisecting an angle. Besides the fact that the participants were high school students, the study did not incorporate CAD. A study closer to CAD is that of Bakar, Tarmizi, Ayub, and Yunus (2009), which compared sketchpad to conventional construction drafting methods.

From the foregoing, work on computer-assisted construction geometry within the realm of CAD remains unexplored. Granted that the above-cited works have enabled a deeper understanding of geometric principles, but none of the studies have attempted to mimic traditional techniques in CAD.

2.2. Descriptive Geometry

Computer applications in descriptive geometry are a well-established area, predominantly utilizing AutoCAD, as demonstrated by the works of Bokan et al. (2009), Nassery (2013), Moreno and Bazán (2017), and Khamrakulov (2022). Descriptive geometry has also been successfully implemented using CATIA CAD software by Rojas-Sola, del Río-Cidoncha, Ortíz-Marín, and Cebolla-Cano (2023), who developed an interactive descriptive geometry platform through CATIA's Visual Basic for Applications (VBA) macros. Recent research, including work by De Ravé, Jiménez-Hornero, Ariza-Villaverde, and Taguas-Ruiz (2016), has extended mobile phone applications into solving descriptive geometry problems. Overall, most research efforts have utilized SolidWorks. Moreover, the study reported in this paper, unlike previous efforts, involved learners directly in developing methodologies for executing the specific area of rabatment in descriptive geometry. Firstly, involving learners in problem-solving aligns with aspects of problem-based learning pedagogy. Secondly, the choice of SolidWorks is particularly significant given its widespread use in both education and industry, especially within the context of Botswana.

3. Materials and Methods

The approaches employed for the two geometric problems are detailed in the following subsections:

3.1. Participants

The participants were first-year undergraduate engineering students enrolled in the Engineering Graphics module offered at the Botswana International University of Science and Technology (BIUST). This module is a core component provided to all students admitted into the nine engineering programs at BIUST. It is the only engineering module available to the participants, with the remaining courses being in sciences, mathematics, technical writing, and computer studies. Therefore, gender and enrollment per program were not considered in this investigation.

Both modeling exercises took place during the semester after participants had received approximately 21 hours of CAD instruction and practice. The construction geometry group was a 2017 cohort that completed the exercise in a single three-hour laboratory session, while the descriptive geometry exercise was assigned as a four-week project. In both cases, participants worked in groups averaging five members for the 2017 cohort and six members for the 2024 cohort.

The different time allocations between the two groups could have influenced the results. The experimental design differs between the two cohorts (2017 and 2024), with varying time allocations and group sizes, which makes direct comparison challenging. The author should acknowledge this limitation and explain how it may have affected the outcomes.

3.2. Construction Geometry Approach

For the construction geometry problem, the author or investigator prepared the comparison matrix in Table 1. The matrix outlines, in column 2, SolidWorks-adapted, step-by-step conventional construction geometry techniques needed to draw a full-scale model of the geometry depicted in Figure 3, alongside equivalent SolidWorks-specific drafting steps.

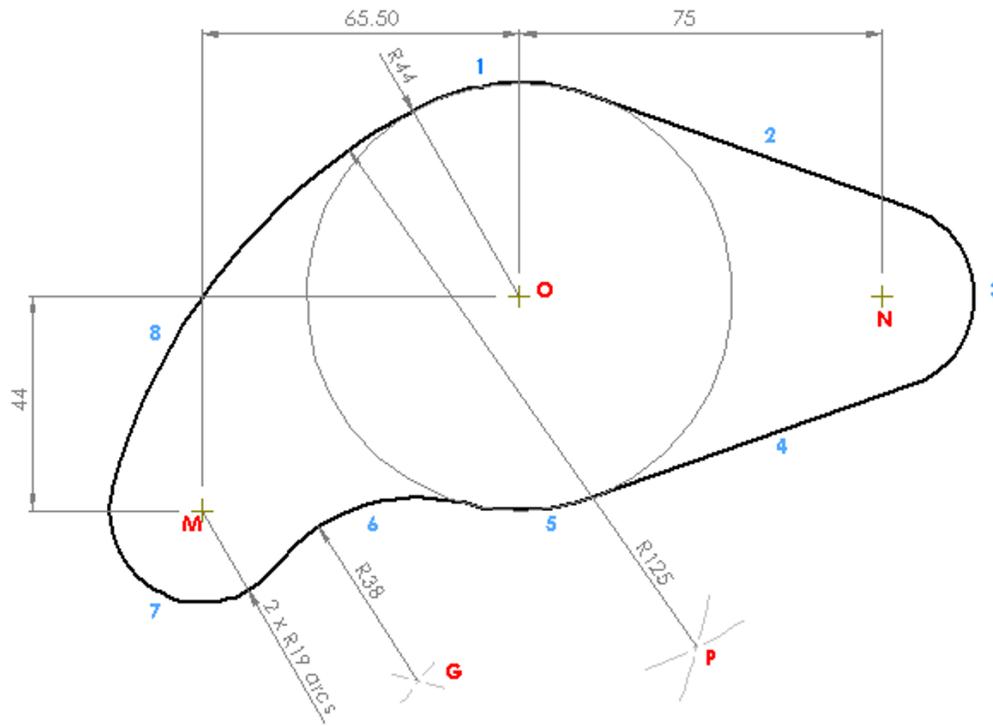
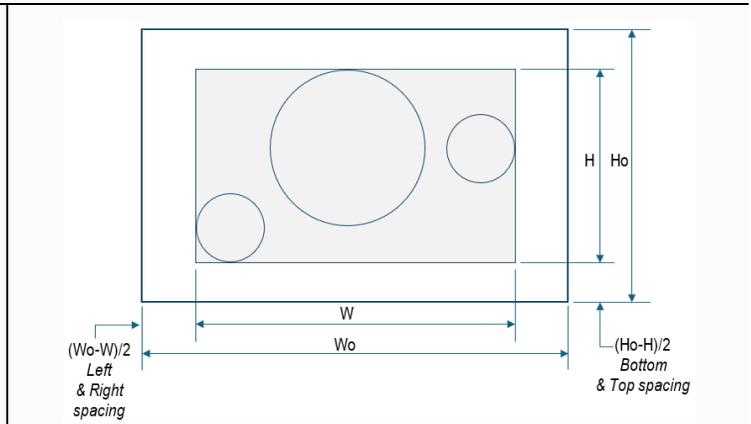
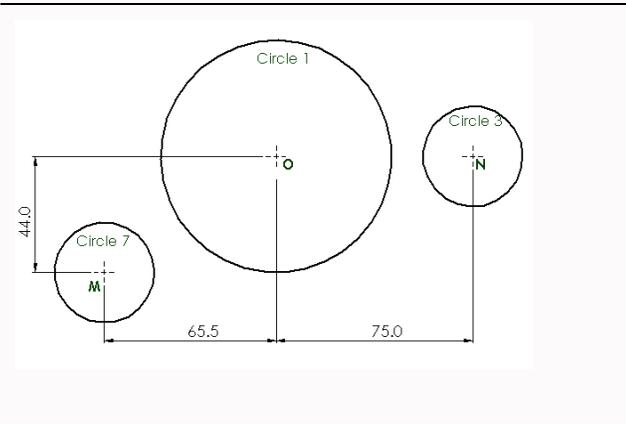


Figure 3. Demonstration model.

Table 1. SolidWorks-adapted construction geometry drafting techniques and SolidWorks-specific drafting techniques.

1. Setting up the basic shape of the geometry.

The basic shape of the geometry is defined by arcs 1, 3, and 7; hence, the three basic circles are drawn according to the dimensions in the figure below. In the CAD approach, the circles are drawn as indicated after selecting either a part or drawing document, followed by an appropriate drawing plane. In the straightedge and compass method, the drawing is first centralized by establishing the height, H (top to bottom - 107 mm), and the width, W (side to side - 178.50 mm), of the geometry. These measurements are subtracted from the height, H_o (297 mm), and width, W_o (420 mm), of the drawing paper, assuming an A3 paper in landscape orientation. The differences obtained are then divided by 2 to determine the spacing from all sides of the drawing paper (see illustration below). Once the drawing area has been defined, the center point A is located first by spacing 19 mm from both the left margin and the bottom margin. From this point, points B and C are then referenced. Additionally, in the straightedge and compass method, the circles are drawn using light construction lines to ensure accuracy and precision in the drawing process.



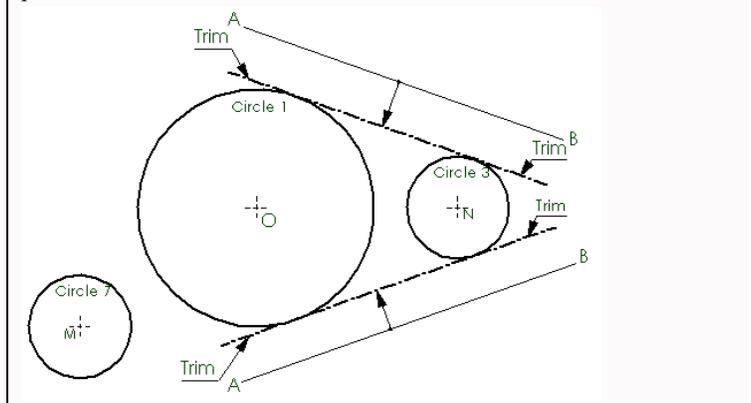
2. Constructing the straight tangent lines 2 and 4 between Circles 1 (Ø88 mm) and Circles 3 (Ø38 mm).

2.1. Straightedge and Compass Approach

Find the start and end points, E and F , of the lines as follows. Draw the center line ON between the circles and bisect it to get point A . Construct a circle B concentric to circle 1 whose diameter is the difference between the diameters of circles 1 and 3. Use point A as center to construct an arc, $Arc C$, whose radius is equal to AO . At the intersection of $Arc C$ and circle B , mark the points D . Draw straight lines OD and extend them to cut the circumference of circle 1 at points E . Draw straight lines from N parallel to lines OE up to the circumference of the circle 3 to locate the points marked F . Points E and F are the exact start and end points of lines 2 & 4.

2.2. CAD Approach Using SolidWorks

Draw the straight lines marked AB at convenient locations above and below circles 1 and 3 as illustrated. Add a tangent relationship between the lines and each of the two circles thus moving lines AB to merge with circles. Trim out the excess portions of the lines.



Following the above demonstration, participants were provided with the models shown in Figure 4 and asked to use SolidWorks to mimic the appropriate construction geometry drafting techniques to draw the models. Essentially, participants were to choose an appropriate SolidWorks sketching platform, either a part document or a drawing document, and use it to sketch or draw the given geometries as they would with a drawing board, compass, and straightedge. The models were selected because they are well-detailed and present unique challenges to the participants. For instance, in Figure 4(a), as per the demonstration model discussed above, this geometry called for the application of tangent arcs and a tangent line, line 5, between arcs as per the approach illustrated under 2.1 for the sample model above. Figure 4(b) calls for the application of techniques to construct a hexagon together with the tangent arcs, while Figure 4(c) introduces the flexi curve 7 & 8 as well as the tangent line 13. As can be seen from the three models, the instructor applied construction geometry techniques as necessary, to which the participants were expected to conform. The assignment was to be completed in a single 3-hour laboratory session and was worked on in groups of about five members.

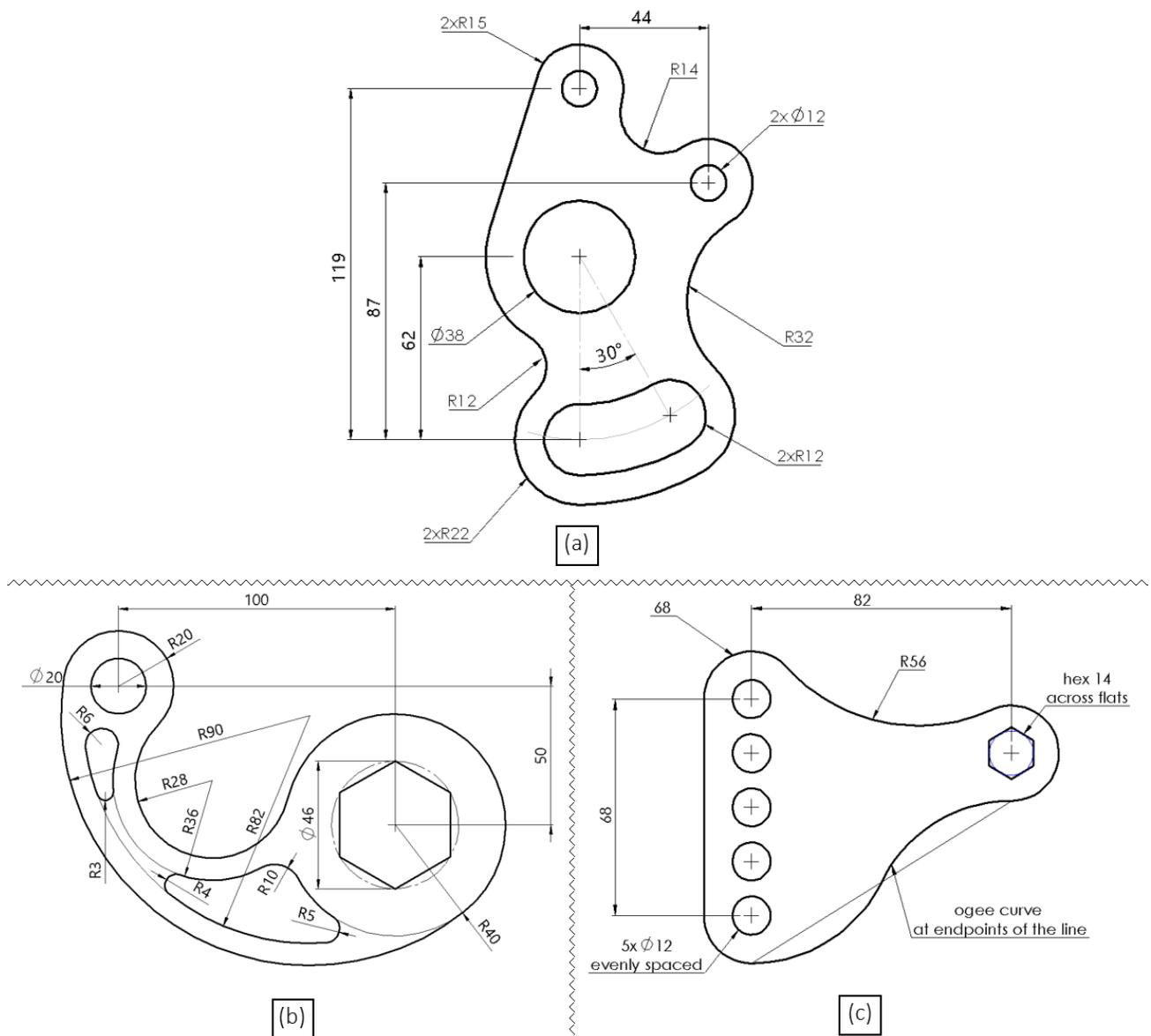


Figure 4. Construction geometry assignment models given to participants.

Source: All models are adopted from Goetsch and Rickman (2016).

3.3. Descriptive Geometry Approach

For the descriptive geometry problem, the participants were to assume the role of an instructor and develop a system to demonstrate the rebatement process in descriptive geometry to a beginner. The brief provided required the participants to create a system that illustrates the standard projection planes, namely the vertical and horizontal planes. A 40mm-sized cube was to be placed in the first quadrant of the projection planes, positioned 50mm in front of the vertical plane and 30mm above the horizontal plane. Participants were also instructed to show how the two views of the cube could be realized on the projection planes, and subsequently, to demonstrate the rotation of the horizontal plane to align with the vertical plane. The step-by-step instructions given to the participants were as follows:

1. Show both the vertical plane (VP) and the horizontal plane (HP).
2. Show a 40 mm cube in the first quadrant, 50 mm in front of VP and 30 mm above HP,
3. Show how the two views (i.e., front and top) of the cube are projected on the planes,
4. Demonstrate the rotation of the HP as it aligns with the VP, and lastly
5. Present a planar view of the above process.

The participants further prepared and presented video recordings to demonstrate the workings of the designed systems.

4. Results and Discussions

This section presents the results from the participants regarding two engineering geometry techniques: construction and descriptive geometry.

4.1. Construction Geometry Results

Figures 5 (a) to (c) are the correct models modelled by the author and instructor. Figures 5 (a1) to (c1) are the corresponding selected best models created by the participants. It is evident from these figures that the models created by the participants, in contrast to those by the instructor, are incomplete. This is because, as can be seen especially from Figure 5(a1), participants tended to overcrowd their sketches with too many details and features all at once, thereby overwhelming themselves. It suggests that the feature-to-feature methodical sketching approach, in which each step is executed one at a time until all features are completed and illustrated in Table 1 of this paper, was difficult to execute in SolidWorks. Moreover, the results also show that most participants became fixated on the automatic feature placement techniques discussed in SolidWorks and did very little to mimic construction geometry techniques as instructed in the assignments. Some features in the models, such as the hexagonal feature in Figure 5(b1), are conceptually incorrect. Another noteworthy observation, which is not evident from the models, is that all the models created by the participants are based on sketches. In other words, the participants opened SolidWorks PART documents and then selected planes on which they sketched the base sketches. In contrast, the instructor used SolidWorks DRAWING documents to sketch all the models.

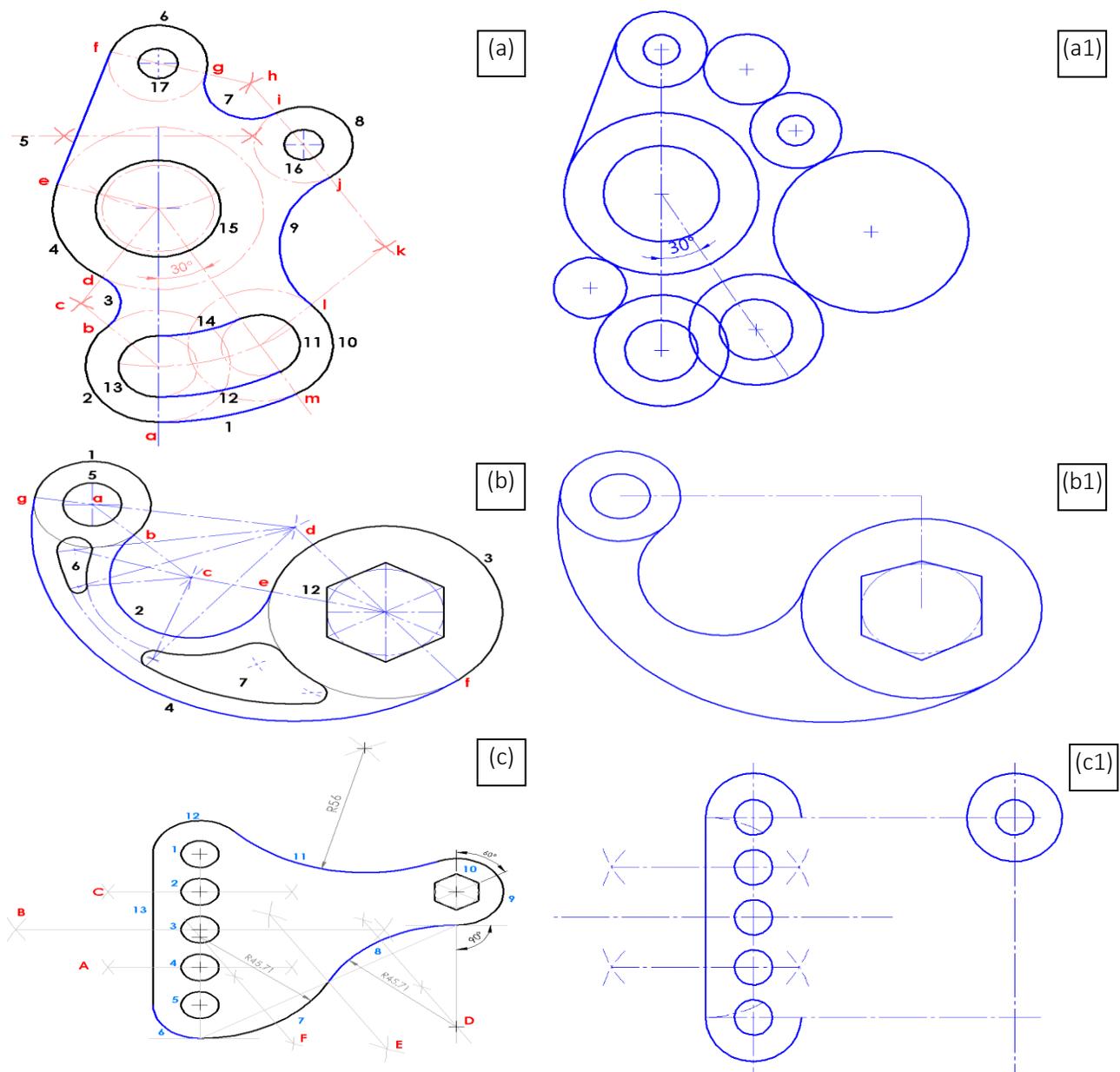


Figure 5. Results by participants for each of the given models.

Note: Figure 5 [a, b, c] show correct models by the instructor using conventional construction geometry techniques as would be the case when drawing using a drawing board; evident in the models are construction lines, numbered and lettered to show features, centers of arcs, and exact start and end points of tangencies between the features enhanced by different color coding, [a1, b1, c1] cleaned up equivalent models by the participants for each of the given models (original models from the participants are given in Appendix A).

4.2. Descriptive Geometry Results

Figure 6 summarises the systems developed by the participants, ordered from [a] to [e] in the sequence of the tasks given in the assignment. The author redrew the models to eliminate inefficient and overly complex techniques used by the participants in the original submissions, as well as to present them in a print-ready format. The approaches coalesce around three distinct patterns, especially for the two starting tasks of setting up the planes and setting up the cube. For instance, in the task of setting up the planes, some participants modelled their own planes as SolidWorks part documents, Figure 6(a1), and integrated the cube into the modelled planes, Figure 6(b1), such that both the planes and the cube were a single SolidWorks part document.

Some groups used the standard SolidWorks front and top planes by setting them to visibility as in Figure 6(a2) and constructing the cube on any of the three standard SolidWorks front, top, and right planes appropriately spaced

as in Figure 6(2b). The third tendency involved participants modeling the planes as separate parts, with the cube as another distinct part, and later assembling the two in a SolidWorks assembly document, Figure 6(a3 & b3).

The diversity of the aforementioned approaches was expected since CAD, as observed by Robison, Thornhill, and Hermon (2015), is a creative process with many solutions. Besides the above initial steps that presented different approaches, the last three steps, [c] to [e], for all the participants who completed the assignment, were observed in that order across all groups. Certainly, this was a result of extensive idea sharing across groups, given the time allocated for the exercise. General details on how each step was executed are provided in the notes accompanying the figure. However, the models were not entirely free of errors. For example, as previously noted, the coplanar rotation of the horizontal plane resulted in the top view appearing suspended in the air, as shown in Figure 6(d). This occurs because a sketch, even when drawn on a surface, does not become part of the surface but remains independent. The participants improvised by redrawing the top view on the rotated plane. A better approach would have been to convert the sketch into a feature of the horizontal plane by creating a minuscule cut, extrude, or simply an extruded feature on the plane. In this way, the feature would move together with the rotated plane.

Another issue that concerned the participants, as illustrated in Figure 6(d), was the cube suspended in the air. The participants tended to hide it to improve clarity. The suspension accurately reflects the cube's true location in space, as specified in the problem; therefore, hiding it may have been unnecessary.

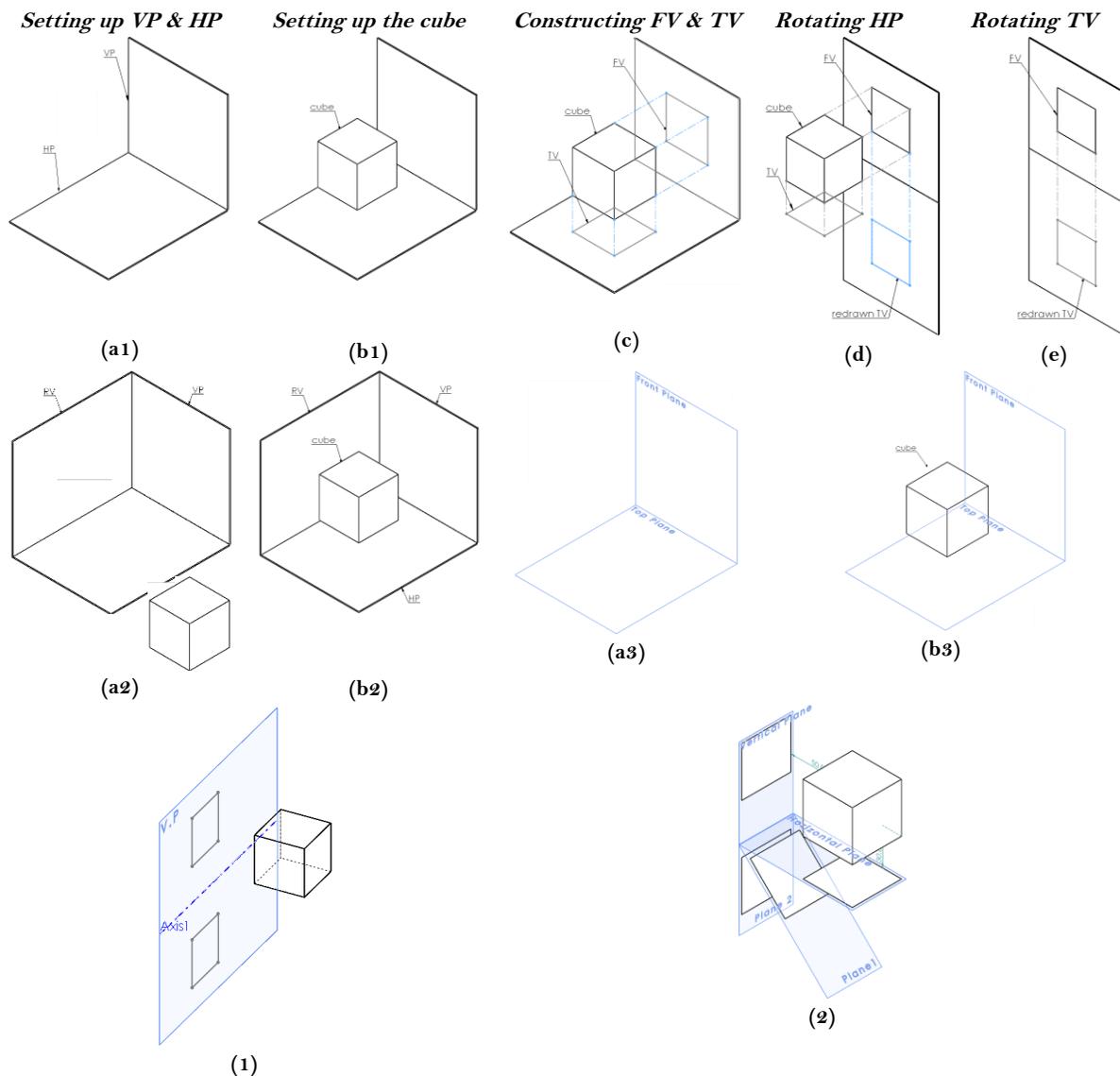


Figure 6. The modeling approaches submitted by the participants are shown in the sequence labelled [ax], [bx], [c], [d], and [e], per the tasks given in the design problem, where x = 1, 2, and 3 denote the differences noted for tasks: drawing VP & HP and drawing the cube. The numbered models are as follows: (1) is a non-conformity, while (2) is a good illustration.

Note: Notes on how the steps were executed:

- (a1). VP & HP† are extruded features; with the VP extruded from a base sketch on SW/FP†, while the HP is extruded from a base sketch at the bottom end of VP.
- (b1). the cube is extruded to 40 mm from a square base sketch of 40 mm directly on VP at 30 mm HP, and offset by 50 mm from VP.
- (a2). Planes (i.e., VP, HP, and RP) and the cube created as separate individual parts.
- (b2). Planes and a cube were joined and spaced out appropriately in an assembly document. Lastly, steps [c] to [e] above were then followed.
- (a3). No planes created, but the SW/FP & SW/TP‡ were set to visible,
- (b3). cube was extruded from a square base sketch directly on SW/FP or SW/TP and spaced from both SW/FP & SW/FP with the Move Face command,
- (c). FV and TV are obtained by converting the edges of the cube onto both the VP and HP using the Convert Entities command.
- (d). HP rotated to 90°, hence the cube and TV are suspended in the air, and a new TV has been redrawn on the rotated HP.
- (e). The suspended TV and cube are suppressed in the final presentation.
- (1). A case of cheating where the single plane (VP) has the cube in front, with views sketched directly onto the planes, and a reference axis inserted at midspan VP.
- (2). A good progressive illustration of the rabatment process, however, with TV gradually shifting towards the axis of rotation, which should not be the case.

Key: †VP, HP & RP -extruded planes: vertical, horizontal & right planes respectively; ‡SW/FP, SW/TP, SW/RP -SolidWorks Planes: Front, Top, & Right planes respectively.

5. Conclusions

The goal of this study was twofold. In the first part, it aimed to explore ways of using SolidWorks to implement traditional construction geometry techniques. The second part of the study sought to engage participants in determining how best to use CAD to apply it to the case of rotating a view projected on the horizontal plane and aligning the plane to the vertical plane, a process sometimes referred to in descriptive geometry as rabatment.

The performance of the participants in mimicking construction geometry methods using CAD or finding equivalent CAD methods that align with construction geometry methods was below average. Although the duration of this assignment was 3 hours, the participants worked in groups in an open-book style, and it was therefore assumed that the participants would perform well. However, that did not help the participants at all. In fact, it appears that the 3-hour duration and the fact that each group worked on a different geometric shape minimized the sharing of ideas across groups. Notwithstanding the above, the results are, in a way, a realistic reflection of the participants' performance.

The results further confirm (Fujita, Jones, & Kunimune, 2010)'s twilight zone problem; the failure to switch from the techniques to the theory behind the techniques to be able to implement the theory when presented with a different space. They, however, negate (Suzuki, 2018), who found that solution strategies in 3D-CAD were similar to those in traditional descriptive geometry.

On the other hand, the descriptive geometry cohort performed very well. However, it reflected a narrower pool of ideas, with a participant-to-idea ratio of 33:1. This is obviously due to the longer assignment duration and the fact that groups worked on a similar problem, both of which presented opportunities for idea sharing across groups.

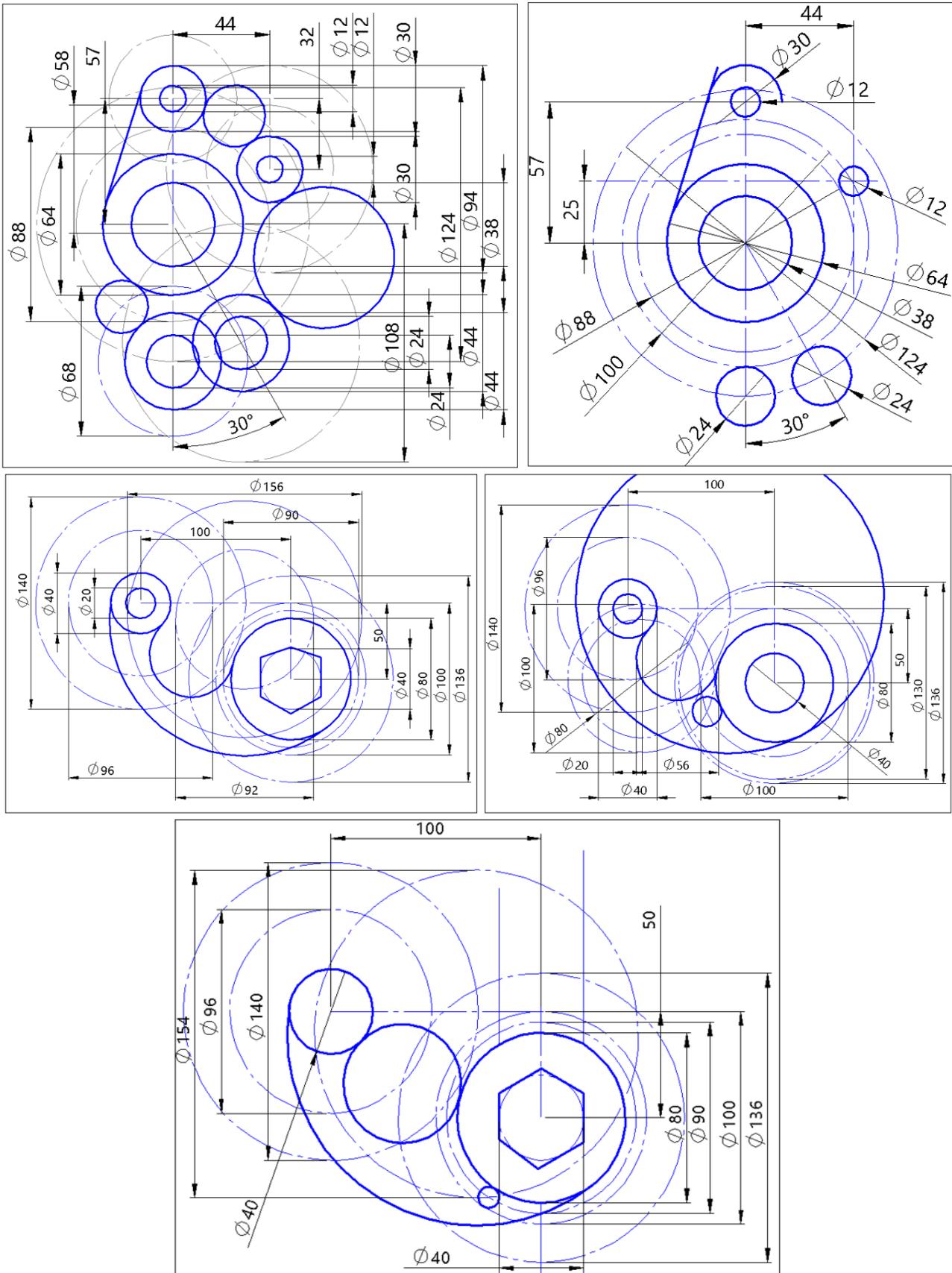
These two experiments are pedagogically significant because, in the first part, conventional manual drawing techniques were extended into a platform that supports e-learning, while in the second part, a flipped learning approach to descriptive geometry was introduced, thereby shifting the focus of learning from the instructor to the learner.

The limitation of this study lies in the fact that the time allocated to the two experiments was disproportionate. As a result, it is not possible to draw generalized conclusions about the performance of the two cohorts of participants. Therefore, it is recommended that future studies address the issue of time allocation to enable a more accurate comparative analysis.

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Appendix A. Examples of original and unedited submissions from participants.