

## GEOMETRY AT THE SERVICE OF ARTISTS – ON PERSPECTIVE IN ALBRECHT DÜRER'S (1471–1528) WORKS

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**Abstract.** The paper presents an extract of forming the principles of perspective construction, construction which had formidable influence on the development and course of shaping European painting. It deals with Albrecht Dürer, his output as an art theorist and one of the greatest artists of the north.

**Keywords:** Descriptive Geometry, central perspective, history of graphics, history of painting, theory of art

### 1 Introduction

Fifteenth century of our era brought very close connections between fine arts and geometry. Getting to know the principles of perspective construction paved the new direction in the history of European painting. This construction allowed artists to present 3 D space in 2 dimensions of a painting surface in an ordered and logical way and till the end of the 19<sup>th</sup> century it dominated in this branch of art nearly totally. Gradual getting to know the principles of perspective and its further development was possible thanks to work and devotion of many then contemporary philosophers and artists. Among them, the output of the most prominent painter of the north, splendid painter 'first and for a long time the only theorist of art in non-Italian Europe'[4], that is to say of course about Albrecht Dürer.

### 2 Searching for knowledge

Born in Nuremberg<sup>1</sup> on 21 May 1471<sup>2</sup>, since he was 15 he had his apprenticeship at Michael Wolgemut's (1434–1519) workshop. Travelling played a vital part in the development of his output and talent. In the years 1490–1494 he travelled across southern German cities of Rhineland and Alsace as well as Switzerland<sup>3</sup>.

He returned from there with great admiration for Martin Schongauer's (c. 1448–1491) art, the master of the north. In the year 1495 he set off to his first journey to Venice<sup>4</sup>, which enchanted him with the works of Andrea Mantegna (c. 1431–1506). He went there again this time for a longer time in the years 1505–1506 [6]. This time he was greatly influenced by

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<sup>1</sup> Nuremberg, thanks to its location on the route from Italy via Venice to the Netherlands, and from the East via Poland and Silesia to western Europe became an important trade center, and it resulted in significant development of artistic group [5].

<sup>2</sup> He was a son of a rich goldsmith, who after coming from Hungary married a young woman from Nuremberg. He was the third child of eighteen children of the Durers [13].

<sup>3</sup> For a longer time he stayed in Basel which was at that time important center of printing and here he learned about engraving [5].

<sup>4</sup> Since the times of Rogier van der Wejden (1399/1400–1464), the northern artists would go to Italy more and more often and for Durer's contemporary it was quite common [2].

Giovanni Bellini's (c. 1427/1430–1516) pictures. Both trips to Italy resulted in profound recognition of new renaissance approach to art and artist.

Among his artistic journeys the most important for us is the trip to Bologna, which took place after 1506 and was mentioned in one of his letter written to his friend Willibald Pirckheimer [7] 'on the issue of knowledge on mysterious perspective, which somebody wanted to teach (him)'. However, it does not mean that Dürer did not use the principles of concurrent perspective, at least in general sense so it must have meant getting to know the basics of construction theory formulated in the 15th century Italy. Who was this mysterious somebody is not really known. Undoubtedly it was a person familiar with Piero della Francesca (c. 1415–1492) and Leone Battista Alberti's (1404–1472) theses as well as Leonardo's method of geometrical construction of shades cast on objects (later included in Dürer's works). Historians' suggestions regarding Leonardo, Luca Paciola or Bramante seem to be impossible, in case of Leonardo<sup>5</sup>, or - according to Białostocki – unlikely in other cases. Many artists unknown to us or theorists might have been his teacher [3].

Less than 20 years later in the years 1520-1521 as mature 50-year-old man Dürer set off to his last artistic journey. That time he visited the Netherlands, whose art by its nature was closer to him than Venice art and it stamped his output. Despite so many various influences he was able to form his own evolving, original style deeply rooted in his native German output and at the same time leading to the new style. According to Jan Białostocki "Dürer's role consisted in perfect acquisition of the theory and practice of Italian Renaissance and merging it together with late north European tradition of late Gothic style. This process gave splendid results and determined the character of German and Dutch art for the whole century." [4].

### 3 Treaty on perspective

Probably having returned from the second journey to Italy our master decided to write vast treaty about painting similar to Italian ones<sup>6</sup>. However, finally the project was not fully realized in its original version. Beginning with lectures on geometry, following the traditions of Italian Renaissance theorist, he got carried away with his scientific passion. As a result a separate book 'Underweysung der Messung mit dem Zirckel Und Richtscheyt in Linien Ebenen Und gantzen Corporen durch Albert Dürer zusammen getzogen Und zu Nutz Allen kunstlieb habend en mit zugehörigen Figuren In Truck gebracht im Jar M.D.X.X.V' (1525, 1538 - enlarged edition), which was far broader than the requirements of preliminary part of general treaty on painting as well as needs and abilities of Northern masters. He must have known these needs as he dedicated the planned treaty to Willibald Pirckheimer when he wrote: 'watching mistakes in painting gives one the greatest regret to a sensible man, even when the piece is done to the greatest detail.

German painters were satisfied with their mistakes since they did not learn the skill of measurement without which it is impossible to become a decent craftsman. However, it was the fault of their masters who did not know this art (...). Since it is geometry which the proper base for all painting, I took the task of creating a textbook for all young people interested in art and thus gave them the base for using measurement with the aid of calipers and lines and in this way get to know and see through their own eyes the real truth.

Thanks to that they will not only love art but also get proper and greater understanding (...) my guidelines can be useful not only to painters but also goldsmiths, sculptors,

<sup>5</sup> Those days he spend in Milano, not in Bologna.

<sup>6</sup> The treaty was to be titled 'Unterricht der Malerei' or 'Ein Speis der Malerknaben' ('Learning painting' or 'The meal of a young painter') [4].

stonecutters, those who make altars and all those who use in their work artistic measuring.’ [4]. As a matter of fact these guidelines were put in four comprehensive books. The first one dealt with linear geometry, sections of cone surfaces, algebraic structure of curves, the second one with the construction of polyhedrons and their extensions, the third one included guidelines of using geometry in construction and architectural practice. For us the most important is the last, fourth book of the treaty where at the end of it as if to crown the lecture we have guidelines on perspective. ‘Perspective – he wrote – it is a Latin word which means seeing throughout. Five things belong to the perspective: first is the eye which sees, second is the projection of an item which is seen. Third is the distance between them and fifth is the distance between the things that you see’ [3].

Dürer presented here basic ‘legitimate construction’ (costruzione legittima) known from Piero della Francesca’s reasoning, based on a listing of values of distances between points of intersection of radiuses of cube vertexes with background obtained in two projections. Dürer’s construction was enriched with a diagram of a stereometric shade from a solid.

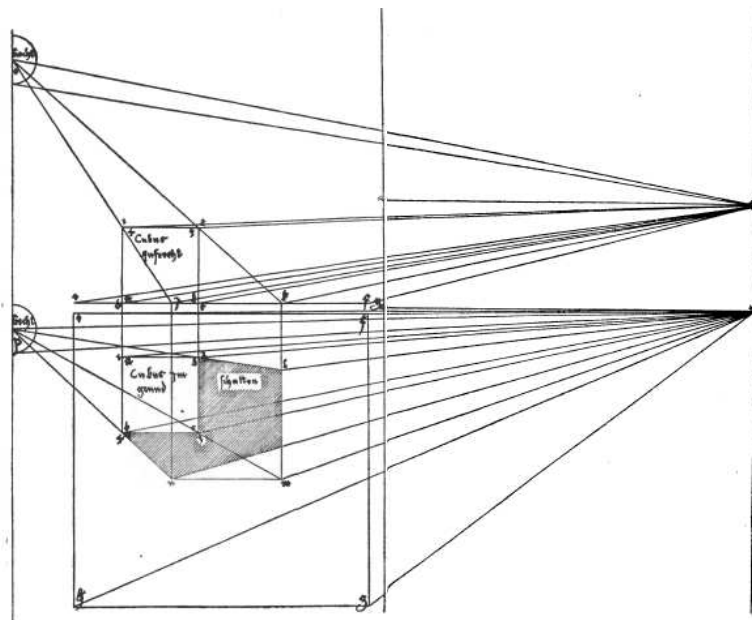


Figure 1: Construction of intersection of a radius bundle with the background surface, exemplified by a cube with its shade with central lightning [7]<sup>7</sup>

What is more, here we can find the simplified method of construction of perspective base,<sup>8</sup> which was shown by Alberty for the first time. On the pictures presented by Dürer (Fig. 2) the lateral projection is in a way overlapping on vertical one i.e. vertical projection and lateral one of non zero thickness of square slabs are united. The altitude of the horizon is determined by the location of a viewer’s eyes. Lateral projection of an eye is assumed not centrally, as typical for other Renaissance theorists, but shifted very clearly to right edge of a

<sup>7</sup> The drawing lacks shaded area of the right front cube vertex. However, there is another drawing a few pages earlier in the same Treaty showing only the shade without perspective and there is no mistake.

<sup>8</sup> This relatively simple construction was, unfortunately, presented in a complicated and unclear way. Similar lecture, as E. Panofsky [11] proved, can be found at Piero della Francesca (“De prospectiva pingendi”, 1480) and Leonardo. The second issue of Dürer’s “Underweysung...” includes construction of perspective of geometrical figures based on perspective from the described square, which was taken from Piero’s treaty [3].

picture. The intersection of lateral projection of vision radiuses going from the rear edge of a square with vertical surface of background determines the altitude of perspective of that edge in the picture. The radiuses of vision going from two remaining sides of the square, which are visible in vertical projection, determine the outline of the perspective.

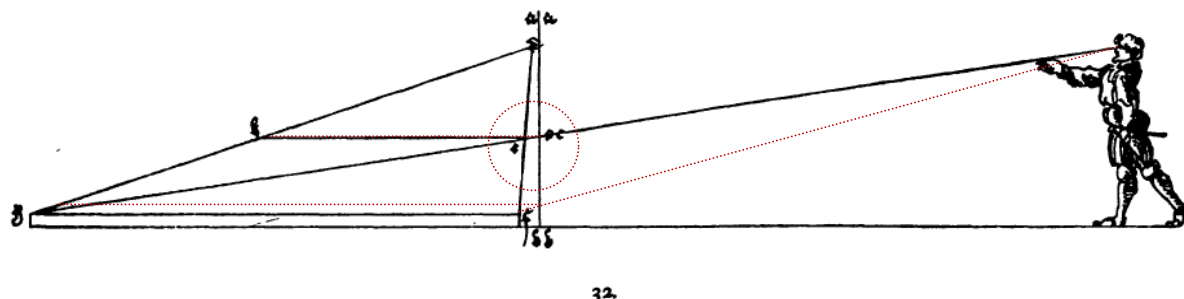


Figure 2: Construction of perspective of square horizontal slab of perspective base [12]

Kazimierz Bartel [1] noticed a mistake here, which does not affect the correct description of a construction. It was marked with a red circle (Fig. 3). The mentioned height of a perspective picture of the farthest square side does not result from the intersection between vision radius and background plane in Dürer's picture number 32 but from the perspective of the vision radius. The identical mistake is consequently repeated on the next illustration number 34 (Fig. 4), where as Bartel puts it he 'does not make use of' the line which is to represent the background<sup>9</sup>. By careful analysis of the picture presented by Dürer one can find one more inaccuracy. If we want our perspective picture of front square edge to unite with lateral projection, as it is in the picture, the background surface would have to cross the end of a segment forming its projection i.e. point f. In the picture, however, it is a little bit shifted and in this case perspective picture of the front square edge is a little higher, at the height of intersection with the background by a suitable vision radius. If there had not been Dürer's description where it was pointed that the line should be drawn through point f, the whole picture could have been interpreted in a different way.

If we assume that the main point called as 'close eye' and graphically mark as a picture of an eye is spaced away from the projection plane only for esthetic reasons (so that vertical line does not cross the eye projection) then we can assume that the whole right side of the picture forms a section of a main vertical surface and the distances between so called 'close eye' *nahe Auge* (main point) and 'far eye' *ferne Auge* (which would form an eye section against the background) created the background depth. According to this interpretation 'far eye' is the point of convergence of square diagonal and thus the whole picture can be seen as correct although not consistent with the description.

On that perspective base one can construct a perspective of any solid. Contrary to other renaissance theorists Dürer did not introduce here, like in a typical renaissance pavement (pavimento), division into chessboard of squares. On his base Dürer drew only diagonal and placed the cube. The diagonal of basis of a cube lies on diagonal of base square.<sup>10</sup> Taking into consideration that in this case the perspective of front side of cube is still a square the task is done.

<sup>9</sup> In K. Bartel's work [1], the illustrations were redrawn with Latin type substituting Gothic one in order to make them more clear, also proportions were changed which highlighted the inaccuracies of the original.

<sup>10</sup> Kazimierz Bartel in his work [1], presents, decodes and pays special attention to one more Dürer's construction, which enables determination of perspective of any point of a square also based on its diagonal.

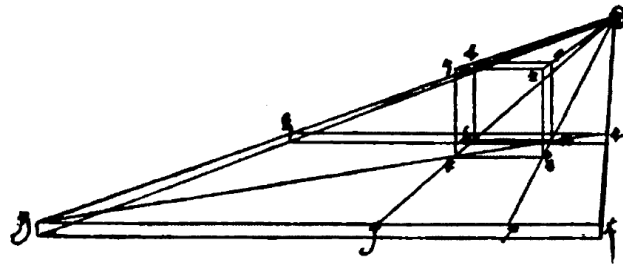


Figure 3: Cube perspective [12]

The reasoning is complemented with the construction of shade construction of the previously presented solid.

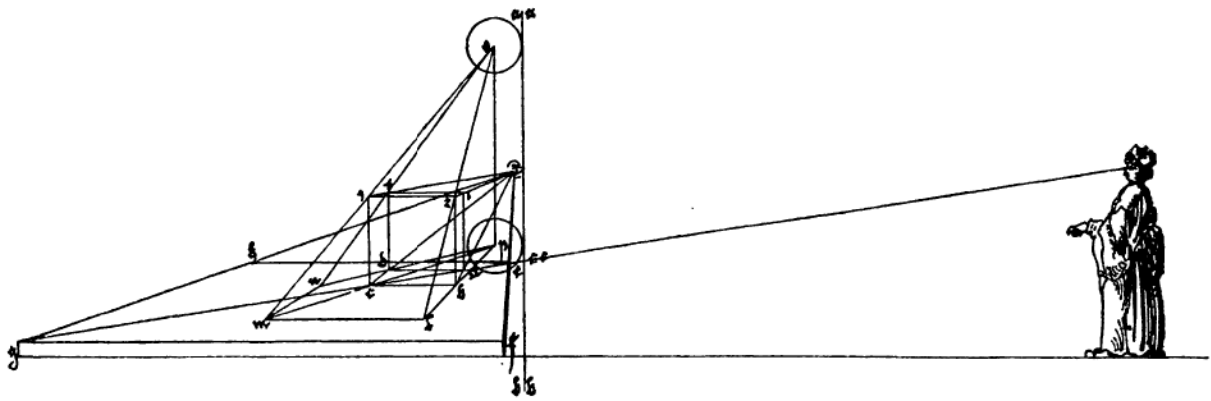


Figure 4: Perspective construction of cube shade [12]

#### 4 Mechanical methods

Much of Dürer's attention was paid to mechanical models of construction of perspective picture of space. Two first suggestions of using a pane of a net are known as 'velum' from Italian theorists. However, here they were illustrated very beautifully with suitable illustrations (Fig. 5, 6).



Figure 5: Illustration of the method of perspective drawing with the aid of a screen with a net [7]

The third of the constructions presented by Dürer will not find an equivalent in Italian treatises. It relies on picture creation by clearly mechanical way, 'without the participation of a human eye', but with the aid of a handle fixed to a wall through which a thread is carried replacing a visibility radius.

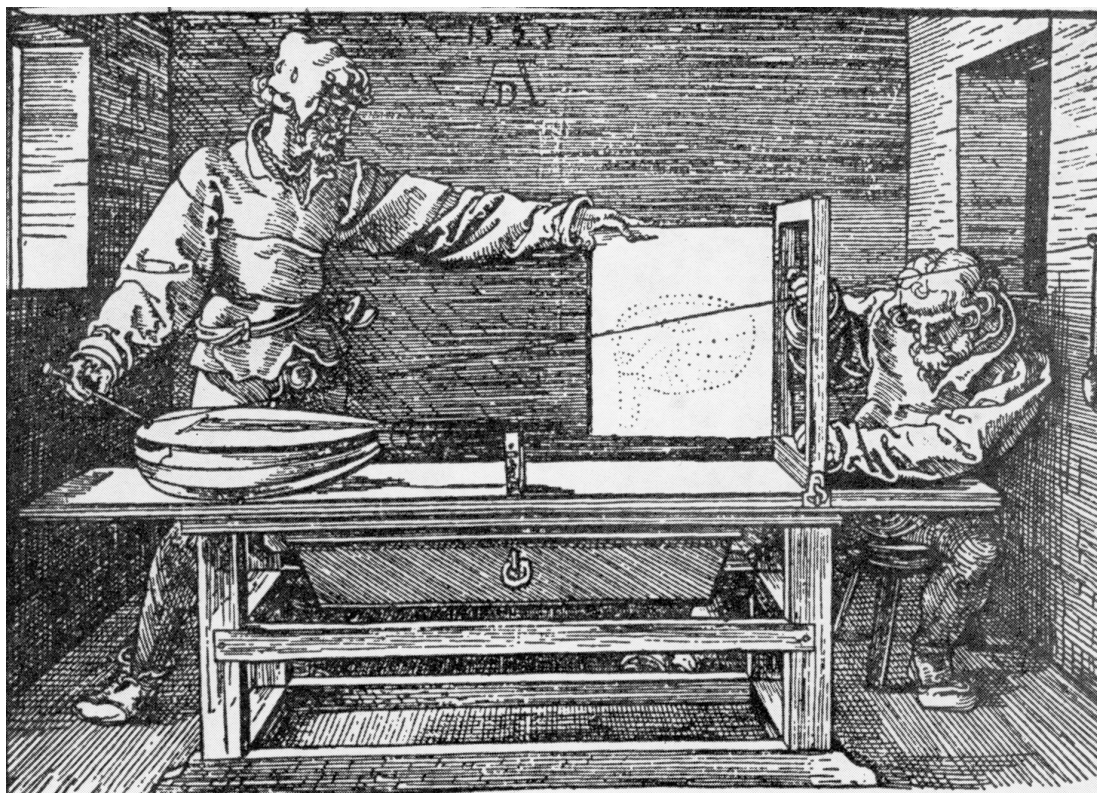


Figure 6: The method of drawing perspective view by means of a thread fixed in a wall and a screen with a movable sheet [7]

The method consists in drawing the points of intersection picture surface by a thread connecting a handle on a wall and consecutive points of the presented object. The points are positioning by means of two threads fixed to a frame. This seemingly simple but tedious in practice method would not have been possible if perspective had not been formulated as an intersection of a pyramid of vision radiuses with a picture surface.

The apparatus built by Dürer can form a simplified physical model of the process of seeing, creating the picture of three-dimensional space on the plane. The vertex of a cone of vision radiuses i.e. the eye is formed by a ring fixed to a wall, a bundle of radiuses is made by a thread stretched to particular points of a presented element, which is anchored in a handle. Movable door and two threads fixed in a frame are to determine the points of intersection of material surface (a plank or a grid) with the picture background.

The presented treaty is one of the three works published by Dürer. The remaining two deal with a little bit different issues. "The science of fortification of cities, castles and villages"<sup>11</sup> published in 1527 in Nurnberg contains interesting town planning ideas. At the end of 'Four books on human proportions'<sup>12</sup> (1528) we can find reappearance of the topic of perspective. This time it deals with the perspective problem of people in motion. Dürer solves the problem by describing particular elements of human body into stereometric solids which

<sup>11</sup> "Etliche Unterricht zur Befestigung der Stett, Schloss und Flecken"

<sup>12</sup> "Vier Bücher von menschlicher Proportion"



take perspective shortcuts [4]. Their perspective projections in various sets are presented by the author with great persistence not smaller than while elaborating of dozens of drawings showing the proportions of human body in the previous pages of the treaty.

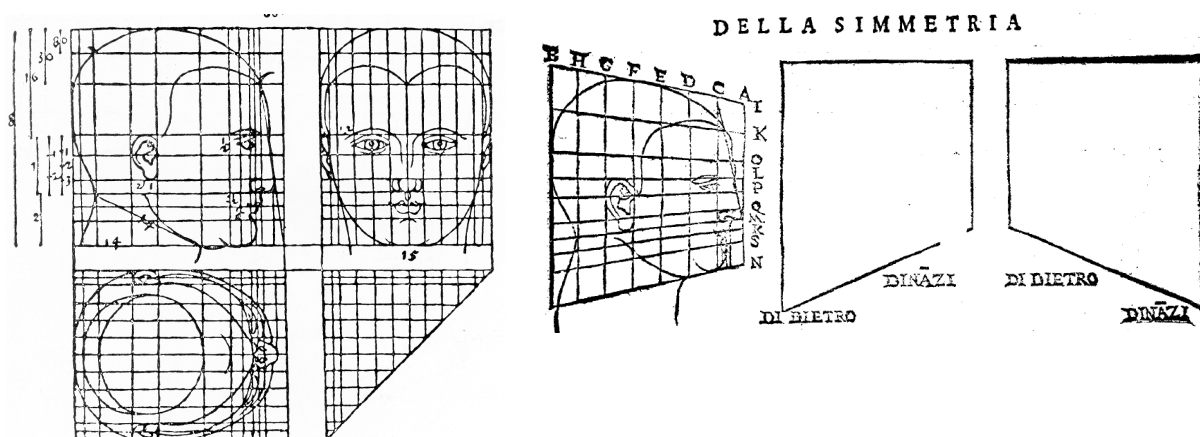


Figure 7, 8: Head projection, the method of showing a head in perspective [8]<sup>13</sup>

Dürer's theoretical works were the first renaissance works written on the northern side of the Alps. His "Underweysung der Messung" was the first perspective treaty, or generally geometric one which was written outside the renaissance Italy and its target were non Italian painters as well as representatives of other professions. It formed first import of perspective theory to northern lands where painters used intuitive, sensual way of presenting reality, formed during XV century in their workshops. It was in a way similar in results to the effect of space picture obtained by mathematical construction [2]. His lecture has been renowned till today and the fact that it was popularized by then modern and cheap technique of graphic art undoubtedly increased its influence on the development of the consciousness of seeing [10]. Although as far as the theory of perspective is concerned, Dürer was unquestionably the pioneer of the north but the influence of his theoretical works was largely limited. According to Jan Białostocki 'written in German, they were probably too difficult for artists unprepared for theoretical thinking'<sup>14</sup> [4].

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<sup>13</sup> This engraving resembles the base for drawing perspective picture of a head from 'Prospectiva Pingendi' by Pier della Francesca.[2].

<sup>14</sup> Latin translation by Joachim Camerarius (1500–1574) made it possible to popularize his works also abroad, mainly in Italy. 'Underweysung der Messung' entitled 'Institutiones geometricae' was published in 1532. 'Vier Bucher von menschlicher Proportion' was divided into two parts 'De Symmetria Partium' (1532) and 'De Varietate Figurarum' (1534).

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## **GEOMETRIA W SŁUŻBIE ARTYSTÓW – O PERSPEKTYWIE W PISMACH ALBRECHTA DÜRERA**

Piętnaste stulecie naszej ery przyniosło bardzo ściśle powiązanie sztuk plastycznych i geometrii. Stopniowe dochodzenie do zasad konstrukcji perspektywy wyznaczało nowy kierunek w dziejach europejskiego malarstwa. Jednym z twórców, którzy w szczególny sposób przyczyniali się do ich wyjaśnienia i rozpowszechnienia jest, jedyny znaczący teoretyk sztuki ówczesnej „niewłoskiej” Europy, Albrecht Dürer. Jego praca "Underweysung der Messung" („Pouczenie o mierzeniu”), swym zakresem znacznie przekroczyła wymogi wstępnej części ogólnego traktatu o malarstwie, a także potrzeby i możliwości majstrów północy. Trzy księgi traktatu poświęcił autor różnym zagadnieniom geometrycznym. Ukoronowaniem całości jest czwarta księga, której ostatnie strony poświęcone są tematowi nowej konstrukcji perspektywy. Dürer przedstawił tu znaną z wywodów Piera della Francesca podstawową "konstrukcję uprawnioną" (costruzione legittima) opartą na zestawieniu otrzymanych w dwu rzutach odległości pomiędzy punktami przecięcia promieni widzenia wierzchołków sześcianu z tłem. U Dürera konstrukcja ta wzbogacona została o wykres cienia, jaki rzuca ów sześcian na płaszczyznę gruntu, przy oświetleniu punktowym. Znajdziemy tu ponadto, ukazaną po raz pierwszy przez Alberta uproszczoną metodę budowy gruntu perspektywicznego.

Wiele uwagi poświęcił Dürer mechanicznym metodom budowy perspektywicznego obrazu przestrzeni. Pisma teoretyczne Dürera były pierwszymi renesansowymi dziełami powstałymi po północnej stronie Alp. Jego "Underweysung der Messung" było pierwszym traktatem perspektywicznym, może ogólniej geometrycznym, napisanym poza renesansową Italią i skierowanym do malarzy spoza Włoch.