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Descriptive Geometry in the Greek Military and Technical Education during the 19th Century

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Abstract

Greece came into contact with Descriptive Geometry (henceforth, DG) relatively early. Monge's courses were taught for a long time in the Greek Military Academy. During the second half of the 19th century the teaching of Descriptive Geometry blossomed. In some of its applications, and especially in the field of Perspective, there were certain ideological obstacles, which were, however, overcome with the advent of Enlightenment. The teaching of DG was extended at the Greek Technical University (Polytechnic School), at the Greek Naval Academy and the School of Non-commissioned Officers (NCO). The French textbooks, written by Leroy or Olivier, were used as the core material for the Greek handbooks. During the last two decades of the 19th Century, the first books which were published in Greek, were mostly translations of the aforementioned French ones. It is also noteworthy that the vast majority of professors were military officers.

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1 Introduction

DG was the development from a technique of representing a three-dimensional object on a plane by projecting it onto two perpendiculars in each plane [18, 4; 2, 887]. In Descriptive Geometry, shape, measures and the relative position of elements of the above three-dimensional object do preserve mathematical precision, which is absolutely necessary in interchangeable parts technology [33, 79].

It was presented in France for the first time. At that time, it was considered a revolutionary method[2] and it was primarily taught at a military school. The science of mathematics in France, mainly during the 18th century, was not connected with universities, but either with the Church or the Army [17, 511][3]. The drawings of Descriptive Geometry helped the co-ordination, development and management[4] of the subordinates of a designer - creator. The teaching of this course helped the liberation of the state from the craft guilds (for example the craft guild of stone-cutters that used drawing). Furthermore, the teaching of Descriptive Geometry helped students develop a sense of precision [1, 141 and 305].

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[2] In France, there was a new mathematical approach, which was suitable for Engineers.

[3] In Greece also, Mathematics had been connected with either the church or the army. During the time of king Otto's occupation, all authors of mathematics books (with the exception of Konstantinos Michail Kouma (1777-1836)) were probably clergymen. On the other hand, after the Greek Revolution and during the rest of the 19th century, the majority of mathematic authors were military officers. The percentage becomes overwhelming if one adds technological books on Architecture, Landscaping, etc.

[4] Even nowadays, military operational orders include drawings (graphics) that allow for troop coordination.

1.1The first steps of Descriptive Geometry

Until the 18th century each professional guild developed its own drawing design techniques, which were non-homogeneous because of the separation of the craft guilds. Each craftsman had to draw what he manufactured by himself. Hence, the designer, the manufacturer and the craftsman were one and the same person. The ongoing demand in architecture (civil as well as military) and machinery design had provided a strong motivation for the discovery of a scientific tool [85, 187] that would allow for the communication between technical scientists (designers) and the craftsmen (manufacturers). The most appropriate science for the creation of this tool seemed to be Geometry. Therefore, it should be adapted accordingly to the needs of technical fields. The implementation of this adaptation called for a perfect knowledge not only of Geometry, but also of graphic arts and space.

The origins of Descriptive Geometry can be traced back to a relatively early era. The concept of planes and altitudes had probably been used quite early. The precise time, however, at which these two concepts were simultaneously used and formed a technique is not clear [2, 887].

Further origins of Descriptive Geometry can be found in designs of Perspective Geometry [66, 163] and Analytic Geometry, which was devised by René Descartes (1596-1650) and in design techniques of stone-cutting, woodcutting and generally in Stereotomy[5] . All the above-mentioned factors led to the birth of Descriptive Geometry [15, 86-106; 23, 559].

Monge’s Descriptive Geometry presented Geometry in a dynamic way. One of its most important elements was the precise presentation of the characteristics of curved surfaces. He discovered that such type of surfaces are created by certain movements of straight or curved lines, and introduced the idea of «families» of surfaces what were related with the movement (e.g. surfaces by revolution). This

[5] For more on this subject, see [85, 97- 183].

new conceptualization brought innovations in Analytical Solid Geometry and Differential Geometry. Each surface could be described in two ways: by the movements of its generating lines and by the attributes of the surface in relation to a neighboring random point on which the movements of the two generating lines intersect. Monge minimized the theoretical principles and sought to implement learning via construction based the principle of examples and exercises. Students learned to deal with protypical problems involving the application of fundamental methodological principals to different kinds of solution. This allowed for the learning of theory as well as appropriate ways of conceptualizing the modeling problems [33, 2003, 79 and 86].

1.2The teaching of Descriptive Geometry in the École Polytechnique of France

Gaspard Monge (1746-1818) began to develop « Géométrie Descriptive »[6] (Descriptive or, as later named in Greece, *Parastatike Geometria*) at the military school of Mezieres[7] at the end of the 1760 decade. Monge was the basic founder of École Polytechnique, the foundation of which could be considered as one of his most important pedagogic achievements. From the establishment of École Polytechnique, Descriptive Geometry constituted one of the basic courses of its syllabus. Initially (1799-1827) it was taught in the first year of studies and later (1818) it was added in the second year as well. It was a course closely connected with architecture and fortification.

The teaching of Descriptive Geometry included courses such as Stone-cutting, Wood-work, Shades and Shadows, Perspective, Leveling, simple machines and also principles of complex machines [29, 43-46 and 376-379]. For the admission

[6] The term Géométrie Descriptive (Descriptive Geometry) appears for the first time in a draft for the organization of secondary education presented by Monge in September 1793.
[7] For the History of Descriptive Geometry see [92]. See also [85] and [66].

of candidates in École Polytechnique examinations were established which initially did not, however, include Descriptive Geometry.

The basic aim of Descriptive Geometry studies was a close connection between theoretical teaching and applications, so that the students would not lose the sense of the practical aim of its teaching. At the same time, the general opinion of its integration in all classes of engineers prevailed. The basic elements in Monge's teaching in École Polytechnique were synthesis and analysis. He stimulated the students to depict the particular advantages of Descriptive Geometry with simplicity, generality and practical application [14, 22 and 23].

Later on, around the middle of the 19th century[8], École Polytechnique's admission examinations included some chapters of Descriptive Geometry which dealt with introductory knowledge, tangents of levels and surfaces' intersections. [12, 45 and 46].

The syllabus of École Polytechnique included Descriptive Geometry which was divided between the two academic years[9] and included also the remaining topics of the course and its applications (Stone-cutting, Shades and Shadows, etc) [12, 97-103]. From the view of professors and hand books, Hachette was succeeded by Charles Felix Augustin Leroy (1786-1854)[10] who taught the course of Descriptive Geometry in École Polytechnique for 35 years [85, 319]. He published the *« Traite de Géométrie Descriptive »* for the needs of the course[11] .

During the same time Théodore Olivier (1793-1853)[12] published the *«Cours de Géométrie Descriptive »* [75]. He introduced and developed methods of changing levels of projection and rotating levels of projection [85, 325-326]. His

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[8] The subject-matter of Descriptive Geometry was extended in 1849.

[9] The subject-matter of Descriptive Geometry included 38 courses for the first year and 32 courses for the second year (applications of Descriptive Geometry).

[10] Hachette taught Descriptive Geometry up to 1815; his successors were Arago and Duhays. Leroy taught this course from 1817 up to 1849 [36].

[11] The 6th ed. of his book was found in Greece [59].

[12] He was an École Polytechnique' graduate. He taught the course of Descriptive Geometry at École Polytechnique as assistant professor (Main répétiteur) for a long time (1830-1844).

above-mentioned book consists of two parts and also contains an Atlas with figures.

These two books, written by Leroy and Olivier shaped Greek mathematic education in this specific field.

2 The first steps of teaching Descriptive Geometry in Greece

The requirement of linear drawing knowledge was the result of the Lancasterian (Monitorial) System of Education (*enseignement mutuel*)[13] which was introduced in Greece as the elementary educational system during the first years of the Revolution (1821). When Kapodistrias, the first Governor of Greece, undertook the government, he tried to strengthen this system [3, 11- 12]. He tried to establish a standardized way and syllabus in schools throughout the newly formed Greek State. Kapodistrias introduced the Sarazin's *enseignement mutuel* handbook [87]. The translation of this handbook was a task undertaken by the committee of pre-education[14]. According to the handbook of Sarazin, the course of *enseignement mutuel* was distributed in eight classes and included: writing, reading, arithmetic, religion, grammar and linear drawing [3, 33-39; 51 30-32]. The topics of drawing of *enseignement mutuel* included the learning of drawing

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[13] The enseignement mutuel, at a basic form, was applied in France, by the middle of the 17th century and onwards. The method was further developed in England by Lancaster Joseph (1778-1838) and Bell Andrew (1753-1832) in order to be intergraded during the period of restoration in France through the re-establishment of the relations between the two countries. In France, Sarazin will perfect it in the enseignement mutuel school that he himself directed and he will also publish the relevant handbook. Greek scholars such as Kleoboulos Georgios (1785;-1864), Politis Athanassios (;-1864) and Kokkonis (1796 – 1867) accepted the effects of the French version of enseignement mutuel instantly. During the period of Kapodistrias and King Otto (until 1852), Kokkonis became a great figure in elementary education and was assigned to translate the enseignement mutuel handbook [3,9].

[14] The committee was established in January 1829, consisted of three members and its main task was to organize elementary education. The members of this committee were Neofitos Nikitopoulos (1795-1846), the French Henri-Auguste Dutrone (1796-1867) and Ioannis Kokkonis.

geometrical figures and moreover the use of simple geometrical instruments [80, 110]. The teaching of drawing provided by the *enseignement mutuel* system was in a very elementary level and did not cover Kapodistrias' educational objective. Apart from school courses he sought to offer young students, the learning of a craft [51, 24]. For the above-mentioned reasons the committee decided to translate the handbook of Linear Drawing [30]. As it was mentioned in the preface of this handbook itself it could be useful not only for the *enseignement mutuel*, but also for the Preliminary School[15]. The teaching of drawing was considered to be beneficial for many craftsmen such as carpenters, stonecutters, builders, woodcrafters, etc [30, g and 1, 2].

The first trace of Descriptive Geometry in Modern Greek Education is found in the relative report in the pre revolutionary magazine Logios Ermis[16] in 1817, which recommended to its subscribers various French books. Among these was Hachette's « Supplem a la Géométrie descript. de M. Monge[17] [17] » [62, 21][18]. The Ionian Academy was one of the first Greek educational institutions where Descriptive Geometry was taught by the professor of mathematics Ioannis Karantinos (1784-1834), who studied at École Polytechnique. Upon his return to the Ionian Islands, he translated a series of French mathematical handbooks the majority of which was published. It is noteworthy that although Karantinos probably translated Descriptive Geometry as well, it was never published. According to a statement regarding Karantinos' endeavor to sell his published books, he mentioned : *"… I became a co-operator of the teachers of mathematics,*

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[15] Preliminary (Prokatartiko) school provided education in order to cover the gap between the Central School of Aegina and the *enseignement mutuel* Schools. Practically, Preliminary school was actually preliminary courses of the Central School for those who were considered incapable to follow the courses of the main classes [72, 376-378; 53, 27].

[16] The prevailing and mostly well-known instrument of the Greek Enlightenment was the pre-revolutionary journal Logios Ermis which was being published in Vienna from 1811.

[17] Refers to Gaspard Monge's book of "Supplement a la Géométrie descriptive" [1811].

[18] List of older and newer publications of French books from various French lists, recommended for the friends of the French literature who were subscribers to Logios Ermis.

so that they may prepare the youth by means of this system and to continue unconstrained in our Academies the application of analysis to every section of Geometry, Descriptive Geometry, Differential and Integral Calculus and the Science of Mechanics, i.e., the field of transcendental mathematics, which I have translated from books written in foreign languages, which I intend to publish in due time, after I have taught them to young teachers." [137]. According to a Karantinos' biographer it was pointed out that he published the Myot(?) Géométrie Descriptive [19, 36]. Karantinos provided more clues in a hand-written memorandum, where it was stated that he taught from Monge's text [82, 304-319]. In the graduation examinations of 1830 we find Descriptive Geometry among the examined subjects, which means that the above-mentioned course was taught during that period [35, 84]. Descriptive Geometry was occasionally taught at Athens University[19] as well, which was established in 1837, as it appears in certain programs[20]. In 1886, the syllabus of Barbakio Lyceum[21] contained only straight lines and levels up to three-orthogonal trihedral angle [4, 691].

[19] The first professor of Descriptive Geometry at the University of Athens was Konstantinos Negris (1804-1880). He was born in Constantinople. He was Neofitos Vamvas' (1770-1855) student in Chios and he took part in the Revolution of 1821. He was sent to France where he was initially a student at École Polytechnique and later on at the University of Paris. He was one of the first professors of Mathematics at the newly established Athens University. He was released from his duties due to political reasons in 1843 and was reappointed at his position after a few months until he was finally released from his duties in 1845.

[20] The University syllabus included the principals of Descriptive Geometry and the intersections of surfaces. The course was taught together with Algebra and Differential - Integral Calculus.

[21] Barbakio Lyceum was founded in 1843 and functioned as a common Greek school and classic high school up to 1886 during which its main objective being the preliminary education of students for further science studies.

2.1The Teaching of Descriptive Geometry at Greek Military Academy

In liberated Greece the first institution in which Descriptive Geometry was taught for the first time was the Central Military School [48]. Kapodistrias' choice to establish a Military Academy or a military polytechnic school was made in the context of the ideas of Enlightenment[22] that prevailed in post-revolutionary Greece. The French influence on the organization of the Greek educational system was catalytic. Given that Descriptive Geometry had great influence[23] in the French educational system, it was also included in the syllabus of the Central Military School (Military Academy).

In 1834, the Bavarians re-organized the Central Military School. [101]. The curriculum was increased to eight years. The first four years were preparatory[24], whereas the last four years were regular (educational). The name of the Academy (Central Military School) was changed into Military School of Evelpides [48, 127]. Soon the four preparatory years were reduced to two. In the new curriculum the teaching of Descriptive Geometry remained as a course, which was taught to 6th year students. At the same time other courses of applied mathematics such as Differential and Integral Calculus were added. It's worth mentioning that the Organization of Military School of Evelpides (Military Academy) was written in both Greek and German due to the Bavarian regency (King Otto was not adult at that time)[25]. Descriptive Geometry was written in the German language as

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[22] A large part of the syllabus of the Military Academy included courses of applied mathematics, one of which was Descriptive Geometry as it was imposed by the mathematic education in the context of Enlightenment. For more see [32, 712]

[23] There was a great difficulty in the definition of technical terms, which resulted to unsatisfactory Greek translations during this period. However, in the applications of Descriptive Geometry, caused greater problems.

[24] The need of preliminary courses was due to the lack of educational infrastructure, and as a result the one informal course of Kapodistrias' period was extended to four.

[25] During King Otto's first period the documents were bilingual (Greek and German). The problem was vast. Three languages were used in the ministry of Military affairs: Greek, French and German. Few Germans spoke the first, most Greeks and few Germans the

«Geometrie Descriptive»[26]. It is observed, that possibly the term "darstellende Geometrie" had not still become acceptable in Germany at that time. In 1837, and for the first time in Greece, the term Parastatiki (representative) Geometria, was used in a document of the Military School of Evelpides [115]. The next traces of Descriptive Geometry appear in 1842, in the proceedings of the Council of Education of Military School of Evelpides (Military Academy). The curriculum was divided in six[27] academic years. In the courses of the 4th year included Descriptive Geometry was also includes, which was taught for one and a half hours per week.

The syllabus contained the Intersections and the application of Descriptive Geometry in Skiagaphy (Shades and Shadows) and Scenography (Perspective)[28] [29]. The course of Descriptive Geometry also contained: drawing buildings and machines, explanations on some topics of Woodcutting, drawing the five types of columns [118]. At the same time it appears that Stone-cutting was not included at the curriculum although during the exams of 1842 students (Evelpides) were asked to draw a "cloister vault" [113], which is part of the Stone-cutting course. As far as Perspective is concerned, the decision to teach that course is impressive in spite of the ideological opposition of the Orthodox Christian theology which

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second and none of the Greek personnel spoke the third language. The situation was improved in 1841 with the decision made by Andreas Metaxas, the secretary of the Minister according to which only Greek would be used. [47, 78].

[26] The official text of the organization was bilingual (Greek and German) as all the documents that were published in the Newspaper of Government. The spelling of the relative German term is Descriptive and not Deskriptive.

[27] In 1836, Otto decided to reduce the School years to seven with the annulment of the first preliminary year. According to the decree the reason was the development of Greek education [98, 178 and 179].

[28] The definition of the term Scenography is found probably for the first time in a dictionary of 1553. According to Floresky's opinion the origin of perspective is found in the theatre (because of the theatrical character of the perspective representation of the world) [28, 41]. In Greece, in order to explain technical terms the authors sought words from antiquity or Byzantium. During the 19th century, for this purpose the term «"Scenography" was used in the Greek area and not the term « Perspective». All the handbooks that referred to perspective were titled "Scenography". The term «Skiagraphy» is met in a dictionary in 1514.

was also present in modern Greece[29]. The Orthodox Christian theology never accepted the existence of the third dimension in art. As a result, in the eastern religious art there were only icons and no statues. The rejection of the third dimension did not stop there but moved to the rejection of perspective; through hallucination of the third dimension we are lead into a “perspective” and thus a symbolic world. Perspective introduced the use of symbols and thus the ideological use that is connected with a specific view about the world (world view). Furthermore it represents the equivalence between the points of the depiction with those of the depicted object. This equivalence alludes to the idea of a model without however, providing a copy or a prototype. Amongst the depiction and the painting there is no place for resemblance. This, however, opposes to the belief that the world is God’s creation (Creator) and the artistic creation is the expression of the resemblance between the creator God and the human creation. The Orthodox religious art is not interested in perspective but in an internal view of the objects which becomes materialized through a reversed perspective [78, 121- 122] [30]. We may say that there is a conflict of opinions between western enlightenment and Byzantine tradition and a rejection of Euclides geometry by the latter. The reasons for that, however, are either not known or unexploited not only for that specific period but even for nowadays [79, 4-5]. Skiagraphy (shades and Shadows) came also in ideological opposition with Byzantine art (Orthodox Christian art). Hagiographers represented theological figures without shading since the shade is not a being. This kind of painting suggested a deformation of ontology[31]. The scenery, from the point of distribution of ideas, changed with the Revolution of 1821. In educational issues there is a clear influence from the ideas

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[29] For more information see [50, 57-80].

[30] More on the ideological rejection of Perspective by the Church see [28, 94 and 251-252].

[31] It should be noted that the Byzantine Art ideology was opposite to that of the Ancient Greeks. According to Aristotle «art imitates nature», while on the contrary according for the Byzantines the artistic creation «is the expression of similarity of man with God » [28, 251 - 252].

of the period of Enlightenment. The main reasons for the changes in the scenery were:

a. The objectives of the 1821 Revolution included the establishment of a European State [84, 167] and also a connection with antiquity [88, 209; 22, 339]. The establishment of a Greek State based on the European model reveals the predominance of the Europeanists (supporters of the ideas of the Enlightenment) in contrast with those who were strictly attached to the eastern way of life. The supporters of Enlightenment achieved to form administrative institutions according to the European political systems.

b. Another parameter that catalytically affected the change of scenery was the French political penetration in the region that was based on the method of the organization and education of army and technology provision [93, 25]. In the case of Greece they provided the funds for the establishment and organization of a Military Academy (Central Military School). Hence they managed to impose their educational preferences, which were in accordance with Kapodistrias' ideas. The state funded education both in elementary and intermediate schools [68, 327], which during the pre-revolutionary period were financed and directed by the Orthodox Church instead.

c. The election of king Otto and the undertaking of the governance by the Bavarian regents established the foundations for an organized European State.

d. Finally another parameter which helped towards the change of scenery, was the independence of the Greek Orthodox Church from the Ecumenical Patriarchate of Constantinople, when Greece started the fight against the Turks. The Greek Orthodox Church wanted to escape from the influence of the Patriarch who was appointed and dismissed by the Sultan.

All these factors affected the overcoming of all those scientific obstacles that were previously mentioned. The students of the Military Academy (Military School of Evelpides) were not given any course books. Stavrides, a Professor of

Descriptive Geometry, who was at the same time the director of the School taught Monge's Descriptive Geometry.

The students kept notes during the class and designed their drawings at the same time, and used these as a base for their study. Professor Stavrides used the same book for the teaching of Shades and Shadows and Perspective as well [123; 120]. Because of this information it is estimated that the teaching of that course used a later edition than Monge's 4th edition of Descriptive Geometry since a supplementary chapter on the Shades and Shadows and Perspective was included from this edition and onwards. Later on, in 1853, the theory of the course was taught for two hours and the drawing for one hour per week [119].

In July 1840 after a proposal by the colonel Spiromilos (1800-1880), commander of the Military Academy, written examinations were established for the first time. He considered that oral exams were unfair and that the professors tried to assist the students by making suitable questions [89, 79-81]. The examinations of the students (Evelpides) in Descriptive Geometry included, according to the above-mentioned decision, both written and oral examinations [110]. The factor of gravity for this course [32] was 8 with a maximum of 10 factors for courses such as Mathematics, Topography and Greek Language (in the first years) [111]. By comparing these factors of gravity we may educe that Descriptive Geometry was a course of high interest. If we examine the factors' distribution in more detail we realize that the military courses had lesser factors in comparison with Mathematics and technical courses, a fact that leads us to conclude that the educational character of the Military School of Evelpides (Military Academy) was closer to that of a Technical University rather than to that of a Military School.

[32] The course's factor of gravity was multiplied by the quality points of the student. The total sum of units (factor of gravity multiply by quality point) of all the courses classified the student (Evelpis) in an increasing line between his schoolmates. The grading scale for each course was from 0-10. The final score for each course was calculated as the average between the oral and written examinations. A student's promotion or rejection was under the evaluation of the Council of Education, which, after the examinations, drew up a protocol that showed which students were promoted, not promoted and those who were to rejected by the School [112].

Tests on Descriptive Geometry were found in the archives of the Military Academy that constitute the first written documents of that course. The first test (written exams of two students [113] was found from the examinations taken in 1840. Out of the two questions the first one was from the Stone-cutting course and more specifically it asked: What is a cloister vault[33], how is it drawn? What is a groin-vault[34] and how is it drawn when built on four columns; how should you draw the ground plan and section? The design solution given by the student Sisinis [35] appears in the following drawing.

Image No 1

The answer to this test can be found in the handbooks of Stone-cutting, which appeared during the last two decades of the 19th century [39, 126]. The second question of the test concerns the Leveling that was taught together with Descriptive Geometry.

In the second test the question was to find the section between a part of the cannon with the "mesoxilio" of the cannon. Although the question of the test is presented as a practical problem, it actually concerns the intersection of the cone

[33] The cloister vault (segmented dome) is a dome placed over a polygonal base. It is not a semi-sphere, but is formed of curved sections, which corresponds to the parts of the polygon on which it rests.
[34] The groin-vault is a vault produced by the intersection at right angles of two barrel (tunnel) vaults. Sometimes the arches of groin vaults may be pointed instead of rounds. During the Byzantine period the groin vaults acquired arcs with different diameter and were elevated so that they cover also orthogonal spaces [57, 635].
[35] He graduated from the Military Academy in 1842 as a warrant officer in the corps of engineering. There is no further information available [47,243].

(barrel) and a cylinder (mesoxilio or pirgiskos[36]). This question refers to the use of Monge's Descriptive Geometry. The answer the student gave appears in the following drawing.

In the same test [108], in another question the shadow of a cross and also the perspective was asked to be found[37]. The answer given was simply a drawing without any written explanation.

The third test [109] found, was about the course of Scenography and Shadows, 1854. The question was as follows: Find the Shadows and the Scenography of a pyramid attached to a triangular base. The answer given was only a drawing[38] without any written explanation[39]. The solution to this problem refers to figure 53 of Monge's book (fifth edition) [70, 2 and 101]. The next text in the course of Descriptive Geometry was from the exams of 1862. The questions were: a. Find the intersection between a cylinder and a plane and the unfolding surface of the section and b. Find the gravity center of a triangular pyramid [114].

The solution to the first problem refers to figure No 27 of Monge's Descriptive Geometry (5th edition) [70, 2 and 101].

From the above-mentioned questions of the exams we may safely conclude that these questions do not refer to preliminary topics of Descriptive Geometry but to more complicated ones such as the intersections of two solid bodies. Almost all questions came from the theory of the courses and not from practical exercises, which were absent from most mathematic handbooks. Hence is seems that the Military Academy attributed great importance to the applications of Descriptive Geometry.

After king Otto's expulsion in 1862 and the arrival of king George A in 1863 the Organization of the Military School of Evelpides changed. In 1864 a new

[36] At that time, the mesoxilio or pirgiskos was the part of a cannon that supported the barrel in the wooden gun carriage.

[37] The finding of the shade of a cross later constitutes part of the theory of Scenography (Perspective) [5, 262-264].

[38] In each exam there was a grade, which was: average, average to good, good, very good.

[39] The drawings in all tests are blurry and as a result their reproduction is not possible.

Organization was published [103, 1-70] according to which the years were reduced to six, for those who were to follow the technical braches of the Army (Artillery and Engineering) and to four for the rest (not technical branches) (Infantry, Cavalry). The first three years were called preparatory and they were common for all the students. The courses’ chairs were increased to 13. Descriptive Geometry (with its applications) constituted one of them together with Constructions. At the same time, in order to cover the course’s teaching needs the employment of a lecturer was also planned.

The subject of Descriptive Geometry was distributed between the last two of the preparatory years. More specifically, during the second year the issues concerning the point, the straight line and the level were taught. At the same time the course of Drawings and the designing of Descriptive Geometry were also taught. During the 3rd year the students were taught curved surfaces, tangent planes on curved surfaces, intersections of surfaces and numbered projection. The designing of Descriptive Geometry was taught in the course of Drawing together with the Topography. In the fourth year (educational) those who followed the technical direction (Artillery and Engineering) were taught the applications of that course, such as Skiagraphy (Shades and Shadows), Scenography (Perspective), Gnomonic projection (manufacture of solar clock), Stone-cutting, and Woodcutting [103, 185]. From the course’s new content it appears that Monge’s book has been substituted by either C.F.A Leroy’s or Theodore Olivier’s. This fact is confirmed by the new course content which contains objects as numbered projection which is included in the previously mentioned handbooks but not in Monge’s book. At the same time, after 1880, when the first Woodcutting educational handbooks first appeared, the new preferences of the Military Academy were clearly displayed. From the above-mentioned courses it is also clear that the applications of Descriptive Geometry such as Stone-cutting, Woodcutting, etc, were supported with extra teaching time.

The above-mentioned Organization was preserved only for two years and hence in 1866 (October 31st) a new one was established. According to the new Organization the syllabus was distributed in five years: three preliminary and two regular (educational). The first three years consisted of general courses, while the last two consisted of military ones. Descriptive Geometry was taught during the first year and referred to the point, the straight line and the plane. During the second year the syllabus reached the surfaces generally, while the third one included: its applications on the Gnomonic projection, Scenography, Skiagraphy, Stone-cutting and Woodcutting. The factor of gravity in Descriptive Geometry was increased to 10, which was the highest one. This increase probably implied the great importance of the course. The course's chair was preserved, but all the lecturers' positions were cancelled [16, 177- 225].

The Organization of 1866 was only preserved for a year. In July of 1867 the operation of the Military School was interrupted and the students (Evelpides) stayed at their homes until a new Organization[40] was established.

In 1870 (23 October) a new Organization was established. The years were increased to seven. The first five consisted of the teaching of physics-mathematics, after the end of which final examinations were anticipated, so that the graduate students were awarded, if they wished, a degree of physics-mathematics with the right to exercise the line of work of a teacher or a political Geometrician (probably like a topographer). The ones who would continue with the remaining two years would be taught military courses. Military courses were considered to be Architecture, Compositions of Architecture, Applied Mechanics, Bridge Construction, Artillery, Art of war, Fortification, Road construction, etc. Comparing the above-mentioned military courses with the physics-mathematics ones it appears that the first ones were mostly applicable while the rest were mainly theoretical.

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[40] In January 1868 and being under pressure, Boulgaris' government was forced to re-operate the Military Academy authorizing the 1864 Organization, which remained until 1870. During that year the Organization was published again.

The chair of Descriptive Geometry was preserved also in the new Organization of the Academy. Its teaching was included in the third, fourth and fifth year, a fact which proves that the course of Descriptive Geometry was not considered to be one of the military courses. The above-mentioned classification indicates that this course was not considered to have a great practical application for the Greek society. This conclusion is also strengthened by the fact that a developed industry,[41] that would require the use of Descriptive Geometry, did not exist. On the other hand, courses such as Stone-cutting and Woodcutting in practice probably had applications on the sector of building and construction (stone constructions, roofs, wooden stairs, etc) and perhaps this is why a more general encouragement to these courses is observed. The construction of fortifications that required the use of drawings of Descriptive Geometry was of little importance in Greece [97, 70].

The syllabus comprised of the following topics: The third year included the basic principals of the course. The fourth contained the end of Descriptive Geometry and its applications in Gnomonic projection and Woodcutting and the fifth included the applications of the course (Stone-cutting, Skiagrapfy (Shades and Shadows), Scenography and isometric planes). The factor of gravity still remained 10. Descriptive Geometry constituted one of the final examinations' subjects for the fifth year [16, 5-47].

In 1882 (July 5th), the Organization once again changes. The education was reduced to five years and included two periods, the physics-mathematics sciences or theoretical department and the military sciences or department of application. The duration of the first period (theoretical department) included the three first years while the duration of the second (department of application) included the

[41] Descriptive Geometry finds practical application in France in the industry that required the production of spare parts. These parts should have been designed by a production engineer and not by the craftsman himself, as it happened in the pre- bioengineering era. Moreover, the precision of mass production of spare parts imposed the existence of drawing, which would provide this attribute. Such precise drawings could be based on Descriptive Geometry.

two last ones. The teaching of Descriptive Geometry was arranged to begin in the second year and to be continued throughout the third including its applications, a fact which confirms the above-mentioned conclusion that this course was included in the theoretical courses. The chair of the course was maintained.

According to the 1882 Organization, if the professors of the science courses considered it essential they could oblige the students (Evelpides) to take notes either during the class, or copy the notes that they would receive during the time of study[42]. The professor was obliged, after two years of teaching the course to submit the students' written notes to the Council of Education, which would either approve the lithographing of the course or with the approval of the minister of Military Affairs its printing on public expense [44, 308-381]. No other change was made on the Organization until the end of the 19th century.

2.2 The Teaching of Descriptive Geometry at the Technical University (Polytechnic School)

On December 31st of 1836 a decree for the establishment of a school that would educate experienced craftsmen in Architecture was issued. This school would be running only on Sundays and Holidays (school of Sundays and Holidays). The education provided was equivalent to the level of secondary technical education[43]. The need for experienced craftsmen, who would work for the building of the palace, was probably one of the main reasons for the establishment of the School of Arts. The construction of the palace begun in 1836 and was completed by 1842. In 1841, the director of the School of Arts, the

[42] Hours in the institute represented the hours that the student was compelled to study. This tradition still applies today.

[43] Lower technical education was provided by military schools that had been organized in the context of the Armory (Technical Body which was part of the Artillery). For more information on lower technical education see: [14, 93-105].

Bavarian captain Friederich von Zentner[44], proposed the establishment of a Polytechnic School that would function on a daily basis, parallel to the school of Sundays and Holidays. The course would last for a year. The School of Arts used the French "École des Arts et Métiers" as a model of organization [73, 35]. The proposal included also a three hours per week teaching of Descriptive Geometry by the professor and architect Charles Laurent[45]. This proposal, however, was rejected. On 22nd October of 1843 the School of Arts was reorganized in three departments: one of Sundays, one daily and one advanced. In the daily department, the practical teaching of carpenters and lapidaries had been anticipated. Descriptive Geometry wasn't taught in any of the three departments [73, 33-72]. In 1844, Lisandros Kaftantzoglou (1811-1885)[46] once again suggested the inclusion of Descriptive Geometry and Perspective[47] in the School's educational syllabus; once again, the proposal simply remained an anticipation. The course of Descriptive Geometry finally began to be taught in 1853 with the appointment of professor Ioannis Papadakis of the University of Athens [73,93] who was teaching until 1856 when he resigned[48]. In 1857, Pilotos[49] was the successor of Papadakis and taught Descriptive Geometry without, however, being paid. According to a report by the director of the Faculty of Arts Kaftantzoglou, this course was taught three times a week for two hours and Perspective was taught two times a week, but the course was seized when Papadakis resigned[50] .

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44 His biographical information is not known. After the Revolution on the 3rd September of 1843 he was exiled from Greece along with all the Bavarians. In 1844 he published a book whose subject was on Greek industry and agriculture.

45 His biographical information and nationality are not known. In documents of the Ministry of Internal Affairs he is regarded as an architect with a name rendered into Greek (Lavrentios) without stating his nationality.

46 Director of the School of Arts who succeeded Zentner.

47 Also included other courses such as Mechanics, Chemistry, Natural, Sculpture, etc.

48 As a reason for resignation, he reported that the professor of Scenography earned more money than himself because king Otto liked him.

49 His biographical information is not known. According to the1851, 1870 etc. officers' records, as well as the Military Encyclopedia [1926] there was not any officer by this name.

50 Kaftantzoglou' s report was written in1860 [73, 131-141].

The hours of teaching allow us to presume that the teaching level must have been relatively high.

In 1863, the Organization of the School of Arts changed and the School was reorganized in three departments: the School of Sundays with a one-year duration, the daily school with a three-year duration and the artistic with a five-year duration. The teaching of Descriptive including its applications was anticipated only for the daily department, whose graduates became masons, topographers, steelworkers and Chemical Technicians. The professor of Descriptive Geometry had a salary of 80 drachmas, which was the lowest, with only exception the one for an Anatomy professor, a fact that indicates that its teaching hours were rather few [73, 159-173].

In 1867 the daily school was named “Biotechnical School” and had three departments: Architecture, Survey and Mechanical Engineering [27, 160][51] . The studies for each department lasted five years. Descriptive Geometry was taught in all three departments during the third year [73, 174-195]. In 1872-1873 the School was renamed as “Technical University” [52] [54]. At the same year, the Public Work Department in the Ministry of Internal Affairs was founded, and in 1878 the department of Political Engineers [38, 175]. The above-mentioned facts contributed towards the upgrade of the Technical University’s graduates. The graduates of the Technical University were offered professional opportunities and at the same time contributed towards the upgrade of the studies.

During the academic year 1884-1885 the course of Descriptive Geometry was taught at the «Biotechnical School» in the third year in all three departments (Architecture, Survey and Mechanical Engineering). The course had an hourly teaching of three times per week. Moreover, Scenography and Shades and

[51] Even thought the provided education was of a high level, the graduation from the Technical University did not lead to managerial positions. Those positions were mostly occupied by officers either from the Military School or from Europe.

[52] Georgios Averof (1818-1899) donated 200.000 Drs for the construction of the building. In 1872-1873 the School was transferred to the unfinished building in Patision Street.

Shadows[53] were also taught in the same year two times a week per one hour and Perspective continued to be taught in the fourth year; the weekly hours spend for this course are, however, unknown [73, 279].

In 1887 the Biotechnical School is abolished, and the School of Industrialists of Arts took its place. This School consisted of three departments: Political Engineers, Mechanical engineers, and Foremen and Topographers. In the first two departments the studies were quadrennial, while in the third department they were biennial. The course of Descriptive Geometry, together with its applications was taught to the Political Engineers and the Mechanical engineers, while for the Foremen and Geometrician (topographers) the applications were not included. The teaching had been placed in the first years of studies. Following the example of the Military Academy, professors who taught for two years consecutively were obliged to publish a book for their course. The text for these books that was delivered by the professor was copied by calligraphers with a special kind of ink and then it was transported in the plate of a lithographic machine. The publication of the books was, without doubt, time consuming. The books were sold to the students in modest prices. Up to 1887, a significant number of educational books had been published (one of them was also Apostolou's Descriptive Geometry). As it is natural, the obligatory and hustled publication of technicals' manual does not lead us to conclude that they were original. They were mostly translations [73, 338 and 339].

During the period 1863-1890, 380 architects, 140 topographers and 40 engineers graduated from the Technical University, while during the last decade of the 19th century 123 political engineers and only 5 mechanical engineers graduated. The reason why the number of mechanical engineers' decreased should be sought in the fact that a developed industry did not yet exist and the existing

[53] It's probably about Skiagraphy (Shades and Shadows) and not Scenography, since the term Scenography is the same with that of Perspective.

one used imported technology which was applied by foreign engineers and craftsmen [38, 178].

2.3 The Teaching of Descriptive Geometry at the Faculty of Non-commissioned officers

The Military School of Non-commissioned officer was established in 1882. The basic aim of this School was to educate Non-commissioned officers (sergeants, head - sergeants) who after their graduation would be named warrant officers in the Infantry, the Cavalry or the Logistics[54] . In order to be admitted in this school one had to take exams[55]. The study in the School of Non-commissioned officers was biennial. Even though the initial Organization did not include the teaching of Descriptive Geometry [44, 382-461], later on this course was incorporated in the syllabus.

3 The first written handbooks of Descriptive Geometry in Greece

3.1 Selection way of instructive handbooks in the Military School of Evelpides

In the Military School of Evelpides, a library that supplied books mainly from France had been organized. The book supply occurred mainly in two ways.

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[54] Two Prime Ministers of Greece graduated from the Faculty of Non-commissioned officers: the general Nikolaos Plastiras (1881-1953) and the general Georgios Kondilis (1878-1936).

[55] The admission examinations comprised of the following courses: Report, Numerical, Elementary Geometry, Shot of Arms, Army regulation, Accountancy, Theory of Exercises, Practical Exercise, Distinguished Shares. The first three courses had the biggest factor of gravity.

According to the first one the Ministry of Military Affairs, through the Greek embassy in Paris, ensured the lithographic courses of the various military schools in France. The Ministry of Foreign Affairs urged the equivalent Ministry of Military Affairs not to let anything about the lithographic books go public. Because of the difficulty of finding these books in bookstores people, who the Ministry of Foreign Affairs did not want to expose, ensured their supply. The commander of the Military Academy asked from the Ministry of War *to order the several lithographic books that were recently sent from France to the ministry to have them sent to the School so that the professors will use them as guidelines for the settling of the courses' subject* [125]. According to the second way the professors of Military Academy followed the scientific developments and occasionally submitted applications for the supply of scientific books. The process was the following: the professor submitted a report through which he justified the purchase of a book, usually in French [126].

These applications were addressed to the Commander of the Faculty that he then submitted to the Ministry of Military Affairs for the approval and the funding of the purchase [130].

A library was also allocated at the Ministry of Military Affairs, which purchased from other countries various useful books for the operation of the army and also the training of officers. The majority of book titles were about the Artillery, the service of officers in the ministry, the Engineer, etc. The majority of these available books were French [133]. The Ministry library loaned scientific books to the Military School of Evelpides [132].

The loss of a loaned scientific book in a foreign language would be reported to the Minister of Military Affairs himself, probably due to the cost and the difficulty of its replacement. The Minister commanded the borrower to either bring back the book or to pay for it. If from a multi volume work only one volume was lost the order was to pay for all the volumes [129].

The selection of a foreign book[56] with the purpose of being introduced in the education of the Military Academy as a base for teaching, took place through the following way. The Ministry of Military Affairs commanded the Military School of Evelpides to evaluate a foreign scientific book. Then, the administration passed the book on to the relevant professor who, after reviewing it, would either recommend it for an inclusion in the education or not. The director of studies of the Faculty who also expressed his own opinion on the document would receive the report of the professor. Finally, the commander of the Faculty submitted the report to the Ministry of Military Affairs, the expert view of the professor and the director of studies. The whole process did not last more than ten days totally [124].

From the above mentioned it is clear that the professors of the Military School of Evelpides were up to date on the new French scientific publications. It is, however, highly probable that the professors of the Technical University were also up to date, since a certain number of them were Army officers. Unfortunately documents pertinent to the purchase of foreign books on Descriptive Geometry were not located, but it is estimated that the process would probably be identical.

3.2 The first written handbooks of Descriptive Geometry in the Military Academy

The first complete written trace of Descriptive Geometry was the Evelpis Petros Saroglos' handwritten notes[57]. These notes are attributed to the above-

[56] I did not manage to locate any purchase or even a proposal for purchase of a foreign scientific book besides French

[57] Petros Saroglos (1864-1920) was born in Athens by wealthy parents. His father was a Greek tradesman of Moldavia. He joined the Military Academy in 1879 and in 1886 he was made second Lieutenant of Artillery. He reached up to the rank of major. In his will he left his enormous fortune and his precious collections to the officers' club of Armed Forces in Athens. The building where the club of officers is currently accommodated is called Saroglio and his really rare collections are exposed in the Martial Museum.

mentioned Evelpis, because his signature is found on pages 2 and 291[58]. They are currently displayed in the library of the Military Officers Club of Athens to which Saroglos was a great donator. Considering the fact that according to the 1870 Organization the course of Descriptive Geometry started at the third year of studies and that Saroglos joined the Military Academy in 1879, the notes must have been written during the academic year 1881-1882 and continued in 1882-1883. Comparing the notes written from page 81 and onwards with Limpritis' book "Courses of Descriptive Geometry, Part B" which was published (lithographic) in [61], we may see that they are identical. Apart from the text, in the first part of the manuscript (page 1-80), Saroglos includes drawings that he himself designed. On the contrary, in the second part (page 81-349) there are no drawings included. There are, however, references that are in agreement with the drawings found in Limpritis' *"Tables of Descriptive Geometry"* (drawings of Descriptive Geometry), which was first published by the Military School of Evelpides in 1881 [60] . From the above it can be concluded that the handwritten notes constitute the lectures of the professor and Captain of engineers' corps Theodoros Limpritis[59]. The manuscripts general contents are the following:

Book 1 (Pages 1-80). Preliminary elements of Descriptive Geometry (Projection of points, lines and planes, methods of Descriptive Geometry (the method of substitution of projection planes, the method of revolution, the method of coincidence).

Book 2 [60] (Pages 81-349). Intersections and tangent planes cylindrical and conical surfaces and surfaces with double curved, shadows of cylindrical and conical surfaces, warped surfaces, surfaces by revolutions (Intersection and tangent two surfaces by revolution)

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[58] The page number refers to my own counting.

[59] It was not possible to find from other sources who was the professor of Descriptive Geometry in the Military school before 1881.

[60] The word "book" is not inscribed but that's the point, since from now on and till the end it constitutes a copy of those that were mentioned in Limpritis' lithographic book.

As it is obvious even from the introductory pages they were greatly influenced by Olivier [75, 1]. The resemblances, however, do not stop here. The reports regarding the methodology development of Descriptive Geometry (Rotation, inclination of a figure and change the projection plans) allude to the notes of Evelpis Saroglos. The methods in Descriptive Geometry (Rotation, inclination of a figure and change the projection plans) reflect the book of Theodore Olivier, since it was only he who developed them [85, 325-327]. Leroy’s handbook of Descriptive Geometry mentions only the change of projection plans, which are mentioned only for reasons of the syllabus of States schools [59, 23].

The book of Limpritis, Courses of Descriptive Geometry, Part B (lithographic): lithographer's workshop of Military School of Evelpides, Piraeus[61] [63]. A part of this handbook constitutes a mixture whose main source was the second part of Theodore Olivier’s Descriptive Geometry [75]. The chapters «on curves and surfaces», «on surfaces that are considered as the wrapping of other surfaces» and «on surfaces from rotation» constitute a direct translation of the corresponding paragraphs of Descriptive by Olivier.

Limpritis had occasionally published Tables of Descriptive Geometry (forms Descriptive Geometry) [60; 61], which referred, not only to his own handbook, but also to the notes of Evelpis Saroglos (teaching). It is highly probable that they had been drawn by Evelpides.

The first handbook of Descriptive Geometry published in Greece was that of the major of Engineer M. Kanellopoulos [41]. The book includes 398 handwritten lithographic pages. It comprised a direct translation of a large part of Leroy’s Descriptive Geometry [59]. It begins with the third section of the 2nd Book (chapter), which refers to the tangent levels in cylinders and cones. It continues

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[61] Research showed that the same handbook was published twice in 1886 and 1888. These two publications can be found in the library of the Military School and are identical [83, 134]. According to this book, the Courses of Descriptive Geometry were only published in 1885**.**

with the 3rd, 4th, 5th and 6th Books. After the end of the sixth book (Various questions) a problem on the air balloon was added [41, 347-351] which does not refer to Leroy's Descriptive. The problem consists of the recovery of altitudes of various points of ground with the elevation of an air balloon in two points of known altitude. The example mentioned has a military nuance and application in the map drawing of hostile regions. The use of the air balloon example shows that it is probably one of the few Greek technical handbooks that refer to this question. The author's report on the air balloon came into contrast with opinions expressed by religious circles. The confrontation of the idea of an air balloon in pre-revolutionary Greece was considered negative by certain conservative religious circles. In fact the idea that the air balloon constituted the beginning for the realization of interplanetary travels was considered as arrogance and blasphemy, which aimed to the human transgression of the determined limits placed by God and reach the heavenly sphere with the aid of technological means, a thing totally prohibited [63, 91-116].

Kanellopoulos' Descriptive Geometry is completed with the seventh book (double curve surfaces), from which the entire 4th section that refers to tangent levels and to strive surfaces in general, is omitted. From the 5th section he translated only a part. The handbook by Kanellopoulos lacks of drawings. It is likely that the drawings were made during the lectures, like during the first period of the Faculty's operation.

In 1893 the handbook of Descriptive Geometry by Tsakakis was published [96] which came to cover the preliminary and elementary concepts that were not covered in the Kanellopoulos' handbook. It was also a direct translation of Leroy's Descriptive and includes subject-matter from the 1st up to the 4th book (on straight lines and levels, on surfaces and tangent levels, ruled and wrapped surface and intersection of surfaces). From the 4th book on cross-sections of surfaces he had omitted a very small part from the end of the third chapter. The book also excluded the part by Leroy on the change of projectional levels [59].

The need for the publication of a handbook by Tsakakis was probably due to the lack of a manual for Evelpides, which referred to the preliminary chapters of Descriptive Geometry.

As it has already been mentioned, in 1885 Limpritis' *Courses of Descriptive Geometry* is being published [61]. It is likely that this reappearance of Limpritis' lectures was due to the fact that the subjects covered in Kanellopoulos' handbook were considered to include somewhat difficult concepts. The existence of two handbooks by Tsakakis and Limpritis at the same time was perhaps due to the fact that on the one hand the first one covered the first chapters of Descriptive Geometry, while on the other hand the latter covered more advanced concepts. In these two lithographic books, the courses on Isometric Projection **(***Planes cotes***)** were excluded; it was, however, judged by the Faculty that they were essential for a completed knowledge both of Descriptive, and Landscaping. For this reason, in 1887 the captain of Artillery G. Stournaras was also employed by the School as the third professor of Descriptive Geometry, who published the Courses of Isometric Projection and Gnomonic projection in 1887 [90]. The first part of his book refers to the method of isometric projections and constitutes a direct translation of the equivalent part in Leroy's book [59]. The above method used only one projectional level and in the horizontal projections the altitudes were added, which show the height of various points above a stable plane. The method of isometric projections had applications in Fortification and Topography[62] .

The handbooks by Tsakakis and Limpritis were reprinted, a fact that proves that they were probably used for a long time. If we compare the content of the handbooks of Descriptive Geometry by Kanellopoulos, Limpritis and Tsakakis with the subjects of the Polytechnic Faculty in France not only in the admission examinations, but also at the first year of studies, they show that the teaching of the course in the Military School of Evelpides belonged to higher education in

[62] This method is still applicable in Topography and mainly in the imprinting of the ground on a map.

order for graduates to respond to the duties of engineers at Public Works which they mainly undertook after their graduation (mainly those of Engineer).

3.3 First written handbooks at the Naval Academy

Unfortunately we do not have much information pertinent to the education at the Naval Academy. Some information exists in the album published for the celebration of 100 years of the Naval Academy (Σχολή Ναυτικών Δοκίμων) in Piraeus [1984]. In this album certain documents referring to education are also included.

Initially, the Naval Cadets were educated in the Military School of Evelpides following the same syllabus up to 1843. For a better surveillance of the education of these Naval Evelpides (Cadets) as vice commander of the Military School of Evelpides the Swedish Captain Carl Bromg (His biographical information is not known) had been placed[63] [117]. In 1845 the first Naval School was established in the corvette «Loudovikos ». The syllabus anticipated biennial study and in the first year included the teaching of Descriptive Geometry and Shades and Shadows in a weekly base[64] while in the second year the teaching of Shades and Shadows continued for a 75 minutes lecture once per week. The courses began in July 1846, but for various reasons in March 1847 the education started to rapidly decline. For the period 1870 – 1884 the Military Academy continued to educate once again Naval Evelpides [142, 20]. For the first time in 1884, the Naval Academy functioned independently from the School of Evelpides. The study was quadrennial and the teaching of Descriptive Geometry had been included in the courses of the second year [142, 46].

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[63] The Bavarians called some naval officers from Sweden in order to train men of the Greek Navy, because they came from a neutral country and not from England, France or Russia.

[64] The teaching of Descriptive Geometry was anticipated every Monday roughly for two hours (one hour and three quarters) and Skiagraphy (Shades and Shadows) for an hour and a quarter.

Through research, a book on Descriptive Geometry written by the Captain of Artillery Petalas Konstantinos [with no chronology] was found. Even though the book does not mention the year of publication, it was probably published between 1884 (the year that the Faculty of naval Cadets was founded) and 1892 (year of promotion[65] [67] of the author Petalas into major [25, 33-34]). The lithographic book included the term Parastatiki (Representative) instead of Perigrafiki (Descriptive) for the first time in its title. It consisted of 135 pages and five additional pages with the contents. This handbook was separated into two sections; the first one had the title “Graphic representation of bodies” (Descriptive Geometry) and the second one “Applications of Descriptive Geometry”. The first section consisted of eight chapters (Introductory knowledge of projections, Problems on the straight lines, of lines and planes, problems on trihedral angle, representation of surfaces, tangents of levels of surfaces, the sections of surfaces, the helix and ruled helical, isometric projection), while the second one comprised of four chapters (Shades and Shadows, Scenography, Gnomonic projection, Woodcutting). The book did not include any drawings. As it is obvious even from the chapter’s introductory information, the book reflects Leroy’s views. Petalas’ Descriptive Geometry poses almost the same questions with those of Leroy’s. It does not, however, refer to the question of change of projection levels at all. The resemblances continue in the solution of the trihedral angle and he mentions the three out of six of Leroy’s cases. The resemblance to Leroy’s handbook continues throughout all first six chapters. The seventh chapter in Petalas’ book refers to the helix, which is also a translation from Leroy’s book. The comparison between the chapter of Isometric Projections in Petalas’ Descriptive Geometry with Stournaras’ handbook “Courses in Isometric Projection and Gnomonic projection” shows that both are translations of the equivalent chapter in Leroy’s Descripive [59]. The first handbook constitutes a selective translation of certain distinctive sections, while the second is a direct translation of Leroy’s entire "Isometric

[65] Petalas had the rank of Captain between 1883- 1892.

Projection”. Petalas’ selection focuses on mentioning sections of Descriptive Geometry from the introductory notes up to the sections. The only addition, besides the above-mentioned selections, was on the helix unit that had practical application in the naval science. It appears from this selection that the content of the course was similar to the one of admissions’ examinations at the École Polytechnique.

3.4 The first written handbooks of Descriptive Geometry at the Technical University

The first handbook of Descriptive Geometry published for the needs of the School of Arts (Technical University) was written by Apostolou in 1883 and was titled “Courses of Descriptive Geometry” [7]. This lithographic book consists of 126 pages and contains 92 drawings. Its contents are distributed between four chapters: projections of point and determination of its position via the projections, planes, projections of curved lines, planes of cylinder sections and rotation of surfaces and the section of those surfaces. The contents of this handbook are similar to the required subjects of the admissions’ examinations in the Polytechnic School of France. In Apostolou’s handbook the methods of Descriptive Geometry are not mentioned. The answers he gives on the questions on finding the angle between two straight lines, the angle between two planes and the minimum distance between two straight lines do not include the use the Descriptive Geometry’s methods [7, 16-22, 41-44 and 51-55]. It appears from the content that there are certain influences from the teaching of Limpritis in the Military Academy without, however, being identified with it. The situation becomes clearer through the appearance of a reprint of Apostolou’s Descriptive Geometry that was presented in the department of Political Engineers of the Technical University of Metsovo [1890-1891] during the academic year 1890-1891. In this reprint the following attributes have been added: a chapter on the trihedral angle, a problem in the sections' chapter and more particularly the finding of the projection of the common section between two ellipsoids whose axes are intersected and also, at the end of the book, a section on the basic attributes of several genders' helical. The contents of the book show a development to the teaching of Descriptive Geometry, which overlaps with the course's content in the admissions' examinations at the École Polytechnique. In addition, this reprint includes courses of Shades and Shadows for the finding of the shade of various solids. The page number has been increased to 201 (main Descriptive is covered in 188 pages and the remaining 13 page cover Skiagraphy (Shades and Shadows). The book included 88 drawings of Descriptive Geometry and 10 of Shades and Shadows. The author's thesis appears even from the introductory pages and is similar to the Evelpis Saroglos's handwritten notes (and therefore his and Olivier's book). The resemblances, however, do not stop here. A supplementary section titled «subsidiary planes», which describes the method of sprawl, [8, 27-31] was added. This section refers to several special locations of a straight line's projections one of which is vertical to the line of the ground.

The above method of Descriptive Geometry refers to the handwritten notes of Evelpis Saroglos, which in turn were influenced by Theodore Olivier's handbook "Cours de Géométrie Descriptive". It is noteworthy that there is no reference on the method of change in projectional levels. During 1895 and 1896 Apostolou's *Courses of Descriptive Geometry* had been reprinted [9; 5]. In this reprint besides the methods of sprawl and rotation, the author also included the method of change in projectional levels [9, 37-45], hence solving various problems related with this method. In the chapter on curves the description of various characteristic curves such as the level curves, the lacks, the cycloid, the epicycloids and the helixes, had been added. In the next chapter on curved surfaces and their adjoined planes he had included more solved problems and also a separate section on planes adjoined to uneven surfaces which include paraboloid and hyperboloid with one nappe. In the last chapter that refers to the attributes of helixes and helices, a section on regular helical surfaces had been added. If we compare the contents of the last reprint of Apostolou's book to the subjects at École Polytechnique as far as the admissions' and the first year's exams are concerned, we may conclude that the teaching of the course in the Technical University belonged to the higher education. From time to time there were several additions to the book that included more and more difficult concepts and problems of Descriptive Geometry. This was probably due to the continuous increasing tendency of upgrading the Technical University as a unique Faculty that provided higher technical education. The above-mentioned handbook was published by a printing-house and is the first printed and not lithographic book. It should be noted that the book did not include any drawings.

During the research in the Library of the Greek Parliament another book on Descriptive Geometry was found, without having a cover. The lack of cover makes it impossible for us to determine the author and the year of publication. It is either the first or the second printed book on Descriptive Geometry compared to the equivalent of Apostolou, which was published in 1896. This handbook includes Descriptive Geometry and its applications Skiagraphy, Gnomonic projection, Scenography (Perspective), Woodcutting and Stone-cutting. It does not include any figures and in total it consists of 244 pages (Descriptive covers pages 3-134, Shades and Shadows pages 135-144, Gnomonic projection pages 144-156, Scenography pages 157-179, Woodcutting pages 179-200 and Stone-cutting pages 201-233). The most interesting element of this book is that for the first time it includes bibliography which is the following:

2.1.1.1 Éléments de Géométrie descriptive, par J. Babinet [11].

2.1.1.2 Cours de Mathématique, par C. de Comberousse[66] [21]

2.1.1.3 Géométrie descriptive, par C.F.A, Leroy [59]

2.1.1.4 Applications de la Géométrie descriptive, par Th. Olivier [77]

2.1.1.5 Cours de Stéréotomie, par Mannheim [64]

[66] The author probably used the third edition.

2.1.1.6 Descriptive Geometry, par C. Limpritis

From the above-mentioned bibliography[67] and from the fact that the book is printed and not lithographic emerges that the year of publication should probably be looked for either on the last decade of 19th century or in the early years of the 20th century. The fact that Limpritis' Descriptive Geometry is included in the bibliography allows us to conclude that the author could be a Military School of Evelpides graduate who had perhaps been taught this course by Limpritis. The absence of Apostolou's (Professor of Descriptive Geometry at the Technical university) books from the bibliography is characteristic. As far as the contents of Descriptive Geometry are concerned this previously mentioned book, which lacks cover, comprised of two parts. The first part includes the introduction and two chapters (straight line and level and isometric projection respectively), while the second part six chapters (Sections, Tangent Levels, Ruled Surfaces and growth of this surfaces, polyhedron) from which the final two include Shades and Shadows and Gnomonic projection. The subject that the book covers is the same with that of Apostolou, a fact that leads us to the conclusion that it was probably published for the educational needs of the Technical University.

The author mentions the «Examination of some types of special graphic constructions» in which he describes the method of sprawl using as examples those of Evelpis Saroglos' notes. The next immediate section refers to the«Change of projectional levels». From the above mentioned an intense influence of the author by the Limpritis' Lectures on Descriptive Geometry is obvious. In other chapters in many cases he uses similar definitions and problems with those of Limpritis' lectures e.g. the definition and the types of surfaces that are produced, the sections of surfaces, etc.

With the inclusion of Descriptive Geometry in the syllabus of the School of Arts, the scientific dimension of the technical education was strengthened

[67] All the books that he reports in his bibliography had been published till the mid decade 1880-1890 the latest.

[38,174]. During 1860-1900 the subject matter of Descriptive Geometry becomes more difficult as more advanced concepts and problems were gradually added probably so that it could be adapted to the increased requirements of the technical modernization of Greece. The rearrangement of the Military Academy according to the model of Saint-Cyr [89, 131] after the end of the Balkan wars which coincided with the upgrade of the Technical university during the exact same period [38, 182], was probably because there was no involvement of military men with the public works any more.

3.5 The first written handbooks of Descriptive Geometry at the School of Non-commissioned officers

The first book published for the teaching needs of Descriptive Geometry in the School of Non-commissioned officers was by Moshopoulos in 1883. His handbook comprised of 180 pages, a 25 pages appendix, and also 2 pages on illuminated part. In addition, it contained 211 drawings. Within the 180 text pages, a chapter on the knowledge “of the isometric projection’s method” was included. The Appendix constitutes a continuation of the courses of Descriptive Geometry, which the author probably decided to include *a posteriori*. In its 25 pages he includes “problems referred to the cross-sections of the surface”. Finally, the last two pages have no connection with the main content. They refer to the illuminated part or “surface limit”. In his book, Moshopoulos uses the method of revolution, the method of coincidence, which directly refers to student Saroglos’ notes, which in turn refer to Theodore Olivier’s handbook *Cours de Géométrie Descriptive*. The covered subject-matter focuses on very elementary concepts. The book is not a translation. The author tries to simplify the subject-matter and make it as comprehensible as possible. The contents of the book are distributed in five chapters which respectively include: Representation of the point, the straight line and the plane, theorems on the projections, problems on the point of the right line and plane, curved surfaces and their tangents and knowledge about the isometric projections. The covered subject-matter is inferior to that of the introductory examinations for the Polytechnic Faculty. A comparison with the subject-matter of Barbakio Lyceum indicates that the teaching of Descriptive Geometry belonged to the secondary education of level. This next book of Descriptive Geometry that was presented in the Military Faculty of Non-commissioned officers was that of P.J. Kontogiannis [55]. This is a handbook of 89 pages. It includes an introduction and three chapters. The introduction consists of definitions and information about Descriptive Geometry and its applications (Topography, Shades and Shadows, linear Scenography, Gnomonic projection and the method of isometric projections); the first chapter includes subject-matter about topographic surfaces, the second contains its applications on Scenography and the third includes a Representation of solids and polyhedral's plane sections (this chapter includes 25 figures). The book's level is extremely elementary. At the end of the book the following bibliography from which Kontogiannis drew his information, is mentioned:

2.1.1.6.1.1.1 Cours de Géométrie Descriptive de l'école Polytechnique par A. Mannheim [65].

2.1.1.6.1.1.2 Plans cotes École spécial militaire[68]

2.1.1.6.1.1.3 Diseur sur l'art du trait et la Géométrie Descriptive par la De-la Gournerie [58]

2.1.1.6.1.1.4 Traite de Géométrie Descriptive par C.F.A. Leroy

2.1.1.6.1.1.5 Perspective linéaire par la De-la Gournerie[69]

2.1.1.6.1.1.6 Cours Géométrie Descriptive par Th Olivier.

2.1.1.6.1.1.7 Géométrie Descriptive par G. Monge

2.1.1.6.1.1.8 Cours de Géométrie Descriptive Cours élémentaire de Géométrie Descriptive par A. Jullien [37].

[68] I did not manage to locate this handbook.

[69] La Gournerie, J de, Traite de Géométrie Descriptive, Dalmont et Dunod edn, Paris, 1859.

2.1.1.6.1.1.9 Géométrie Descriptive par J. Kirs[70].

The teaching of Descriptive Geometry to the non-commissioned officers' school was probably included in the subject-matter so that a communication code, in that case provided by mathematics would exist as common ground in the army. More specifically for the case of Descriptive Geometry, it was assumed that an officer could give his subordinates distinct orders based on drawing [1, 69-75].

3.6 The first written handbooks on the applications of Descriptive Geometry

Shades and Shadows, Scenography (Perspective), Gnomonic projection[71] (manufacture of solar clocks), Stone-cutting and Woodcutting are the applications of Descriptive Geometry. The several professors of Descriptive Geometry either published separate handbooks or included in their handbooks of Descriptive Geometry chapters referring to the above subjects. These applications constituted the subject-matter for the second year in the École Polytechnique. Relatively in Greece the inclusion of applications of Descriptive Geometry in the subject-matter classified the course in higher level education. This was probably a unique case in which the graduates would be called to apply Descriptive Geometry.

Stone-cutting. The first book on applications, published in 1883, was Kanellopoulos' *Μαθήματα Λιθοτομίας* [39]. The handbook is probably a translation (because it begins from Book (section) IV and paragraph 582) of a French book (because of the weakness of explaining technical terms, the author

[70] This is probably Kiaes, J., 1883, Cours élémentaire de géométrie descriptive: Hachette, Paris.

[71] Isometric projections are not clearly considered as applications of Descriptive Geometry but as part of it.

uses the French terms[72] together with the Greek ones, which according to his judgment give a better explanation. Unfortunately, the author's influences couldn't be traced, as no French treatise of Stereotomy has been located in Greece. The last paragraph is numbered 730. The author himself mentions certain cases of paragraphs that he didn't translate [39, 94][73] .

Stereotomy[74] is the art of cutting solid materials and mainly stones, wood and metal laminas, in such a way that the various parts are harmoniously connected. Stone-cutting, which is a section of stereotomy, deals (almost exclusively) with domes. The operations of Stone-cutting were needed for the determination of a dome include the following actions:

a. The division of the dome in voussoirs[75], that should have such a shape so that when joined they would constitute a whole.

b. The determination of the areas and the dimensions of each voussoir's sides and faces.

c. The configuration of the drawing and the facets of each crude stone, so that they constitute the voussoirs [39, 1-3].

As it is obvious from the above actions, Stone-cutting deals with the handling of stones (voussoirs), which will shape a dome when they are joined. It is noteworthy that the described actions do not include the manufacturing of the dome (statics, foundation, etc.) as a total. This was the objective of Architecture or Bridge Constructions[76] depending on whether the dome concerned a part of a building or a bridge.

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[72] The author of technical scientific books used to trace back to the ancient Greek author for the definition of technical terms so that they would find a more suitable word. [86, 256-263; 54, 481- 486].

[73] The author mentions that the paragraphs 662-680 are omitted.

[74] Stone cutting and Wood work were sections included in Stereotomy.

[75] Voussoirs were wedged-shaped stones in an arch.

[76] For example in the courses of architecture, details about the construction and about the static of a dome are given [Chors, 1887-1888]. The same applies for the courses on Bridge Construction [34, 1883].

Kanellopoulos translated three chapters from several sections of the original. The chapters include general notes, and deal with spherical and spheroid domes and infiltrations of a dome. The book does not contain drawings even though it refers to some. The next book on Stone-cutting is Apostolou's Εφαρμογές της Παραστατικής Γεωμετρίας [6], which was published in 1890-1891 for the needs of the National Technical University of Athens. This book contains Scenography, Woodcutting and Stone-cutting. Apostolou's section of Stone-cutting consists of two chapters. The first includes the main types of walls (straight walls, "divergent", sidelong, cylindrical, etc) and the second includes several bridges and vaults (intersection of vaults in the various systems of construction, barrel vaults, cross-barrel vault, cloister vault, etc). From the first pages in Apostolou's Stone-cutting the common choices of his basic bibliography and Kanellopoulos' are clear. The definition of Stone-cutting is then repeated and after that, in a similar way, the consecutive tasks that Stone-cutting should follow are also mentioned. The most distinctive aspect between the two Greek handbooks is the difference between the definitions of the terms for Stone-cutting. For example Kanellopoulos renders the French word «panneau» as «phatnoma », while Apostolou as «tipo ». Moreover, the method of cutting "par équarrissement" the first renders it either as "dia goniotomias" or "dia sanidomatos"[77], while the second only as "dia goniotomias". As a matter of fact the same way is described with the use of different terms. Stone-cutting is also included in the handbook that lacks cover (pages 201-233) in which the definitions and the layout of the content do not agree with the above-mentioned documents of Stone-cutting. The clear influence by Olivier and Mannheim (according to the bibliography that is mentioned) on the author the handbook that lacks cover allows us to conclude that Kanellopoulos and Apostolou did not use them for their writings.

In the wider area of Greece, during the Turkish domination, the guild of lapidaries was created. For centuries they built stone bridges, churches, and

[77] Kanellopoulos uses the terms par équarrissement or par dérobement.

various other buildings without the help of drawings (drawings from that era have not been located). They mainly counted on their skill and continuing efforts. Some of the craftsmen - foremen (protomastoras) had acquired great acknowledgement in pre-revolutionary Greece. We may therefore conclude that the manufactures do not exceed the limits of empiricism. The lack of systematic technical knowledge and practice that was imposed by empiricism constituted one of the most important weaknesses for the new State [78, 377]. Even with the foundation of the Modern Greek State the experienced artists continued to have great opportunities. According to a law issued in 1835, the construction of private buildings required the approval of certain limited drawings by experienced artists. The question would only be brought up in 1908 by the Polytechnic Association, without any further discussions and the exercise for the profession of the architect will not be structured until 1930, although experienced artists would still have the right to build edifices up to two floors high [38, 179]. Consequently, it appears that the teaching of Stone-cutting in the Military School and in the Technical University was related more to theoretical training and least to practice. Perhaps it was only used in certain cases for the construction of public buildings or projects. Also, the enormous power that the guild of lapidaries (experienced artists) had, was clear not only by their rejection of the engineers but also because they themselves actually substituted them. The course of Stone-cutting had probably been incorporated in the Greek education for two main reasons: due to the copy of French syllabi and possibly because the Greek engineers were able to supplement their education in Descriptive Geometry.

Woodcutting. In 1883 Kanellopoulos publishes the *Courses of Woodcutting*, which is the first book of that subject in Greece. The book constitutes a translation of some French treatise. Kanellopoulos probably even uses the same number of paragraphs that were used by the French author. He begins from Book (section) E and paragraph 876 and finishes with paragraph 976. He includes, in general, the following topics: Generalities, roofs, staircases[78]. Woodcutting and Stone-cutting had similar content. However, Woodcutting's main interest was the design of connections between timbers, roofs, staircases, etc.

In 1888, Tsakakis publishes *Courses of Woodcutting*, which is actually a new translation of the same French book that Kanellopoulos had used. Compared to Kanellopoulos' translation, Tsakakis removed from the subject-matter the chapter that referred to beams and wooden staircases. There isn't any other independent book on this subject. Courses of Woodcutting can be found in Apostolou's book *Applications of Descriptive Geometry* [6] and in the book of Descriptive Geometry that lacks cover (pages 179-200). The influence on both authors from a common French book is obvious even from the first pages of the book. According to the bibliography, when writing the section about Woodcutting, the author of the book that lacks cover used the books of Th. Olivier, *Applications de la Géométrie Descriptive* and Mannheim's *Cours de Stéréotomie* as a basis. The resemblance of Apostolou's Woodcutting with the book that lacks cover allows us to conclude that he was also influenced by the same French books. The chapter of Woodcutting in Petalas handbook [81, 128-135] only mentions the fittings of beams the choice of which refers to Kanellopoulos' [40] and Tsakakis' [94] *Courses of Woodcutting*.

Kanellopoulos and Tsakakis describe fittings of beams in the first chapter of their courses on Woodcutting. The absence of sections on roofs is predictable since it had no practical application in shipbuilding. It is believed that Woodcutting's practical use was mainly for the manufacture of roofs, wooden staircases and mainly public buildings.

Skiagraphy (Shades and Shadows). In 1884 Kanellopoulos also published *Courses of Skiagraphy*, which is the first book of that kind. Just like Stone-cutting, this book constitutes a translation of a French handbook, as it uses French

[78] The plane that goes through the smaller sides of the roof and has a triangular shape is called "croupe droite" (croupe).

technical terms in order to explain the Greek ones. The handbook of Shades and Shadows begins from Book A and paragraph 1 and finishes at 210. It comprised of three chapters: Theory of Shades, Various Examples and on brilliant points and tones of shades. A section on Shades and Shadows also exists in the book of Descriptive Geometry that lacks cover (pages 135-144). After comparing the two texts it seems that the two authors were influenced by different French authors. The author of the book that lacks cover states that he used Olivier's applications of Descriptive Geometry and Mannheim's courses of Topography, so it is easy to conclude that Kanellopoulos probably used other French authors. Petalas' [Petalas, the year of publication is not mentioned, 83-91] chapter on Shades and Shadows mirrors Kanellopoulos' [42] views as they are developed in his handbook *Courses of Skiagraphy* (Shades and Shadows). We may observe that Petalas uses certain introductory information and then gives two applications of Shades and Shadows that refer to the Shade of the door and the Shade of the ball. In his introductory notes, Petalas omits much, which are included in Kanellopoulos' extensive introductory chapter (General Notes). In the cases of the Shade of a door [81, 86-89] and the Shade of a Ball [81, 89-91] the growth is identical with the one that Kanellopoulos gives in the Shade of a gate [42, 23-27] and in the Shades of a ball [42, 18-22]. The Shades and Shadows was a method of Descriptive Geometry through which it was possible to clearly conceive an object that is known through its projections. The chances that the Shades and Shadows had practical applications are great. The architects that used it made it easier for their funders to clearly comprehend the work they were going to fund.

Scenography (Perspective) is the accurate representation, upon a single plane, of its details of the form and the principal lines of a body. The first courses of Scenography are found in Apostolou's *Applications of Descriptive Geometry* [6][79]. Tsakakis [95] published the first monograph in 1889 for the needs of the Military School of Evelpides. This handbook probably constitutes a direct

[79] The courses of Scenography cover 78 pages.

translation of a French author. It starts from Book (chapter) B and paragraph 241. The third course of Scenography is the one included in the book that lacks cover. All three texts deal only with linear Scenography, which represents the shapes of objects only with lines contrary to the “Aerial Perspective”, which uses a proper coloring to all parts of the representation. The teaching of Scenography in Greece referred to the linear only.

The chapter on Scenography in Petalas’ handbook [81, 92-119] could be characterized as a selective reproduction of Tsakakis’ Mathimata Skinografias [95].

These three texts on Scenography are obviously influenced by three different French authors. It is possible that Scenography had practical applications. The architects that used it, avoided specialized drawings and helped the none-experts to clearly comprehend the work that was under construction.

Gnomonic projection. Gnomonic projection refers to the carving on a plane of lines, each of which indicates the shadow of a protractor at a specific time every day throughout seasons. The horizontal table is called gnomon and the whole construction sundial/solar clock[80]. Gnomonic projection constitutes an application of Descriptive Geometry and more specifically an application of the general theory of Shades and Shadows (theorie des Ombres). The first courses of Gnomonic projection are included in Stournaras’ book *Courses of Isometric Projections and Gnomonic projection* [90]. The cover of the book shows that the content of Gnomonic projection was taken from Leroy’s book [59]. His text probably constitutes a direct translation of an equivalent French one. It begins from paragraph 538 and ends at paragraph 581. A text on Gnomonic projection is also included in the book on Descriptive Geometry that lacks cover. Comparing the definitions found in Stournaras’ courses of Gnomonic projection with those found in the book that lacks cover we may realize that there is a considerable

[80] Gnomonic projection was familiar in Greece. Three manuscripts written during the 18th century have been found. They are titled *Principals of Gnomonic projection* and refer to the construction of a solar clock [45, 340- 341].

resemblance to the initial definitions and in the preliminaries of the course. However, the resemblance is not continued and the distribution of the subject-matter is different. The fact that both authors used different sources is confirmed by this lack of resemblance. Unfortunately, the weakness of retrieving the French books does not allow us to compare them with the equivalent Greek ones. Petalas' chapter on Gnomonic projection [81, 120-127] refers to Leroy's Gnomonic projection [1884], which was translated by Stournaras. Just like in the following chapters, Petalas selectively repeats Stournaras' text and by extension Leroy's. It is not certain whether there was a practical application of Gnomonic projection or not. An attempt to determine the handbook that influenced the authors of Descriptive Geometry's applications in the Military School of Evelpides, will be attempted, based on the books' external characteristics. All the books on the applications of Descriptive Geometry that were published by the School (Kanellopoulos, Stournaras and Tsakakis) probably constitute translations of only one French handbook. The certainty that the original is French is indicated by the wide use of French words next to Greek ones (probably ineffective for that time), which were used so that the lack of suitable Greek terminology can be exceeded and the study of technical books can be standardized. The fact that these are translations of only one handbook is shown by the observation of the increasing numbers of the sections (books), the chapters and the paragraphs. It is estimated that there is an increasing connection which starts from Kanellopoulos' Shades and Shadows (paragraphs 1-210), continues with Tsakakis' Scenography (paragraphs 241-378), Stournaras' Gnomonic projection section (paragraphs 538-581), Kanellopoulos' Stone-cutting (paragraphs 582-725) and ends with either Kanellopoulos' or Tsakakis' Woodcutting, which is a translation of the same French text (paragraphs[81] 876-976). The fact that Gnomonic projection constitutes a translation of Leroy's text while Kanellopoulos and Tsakakis translated Leroy's

[81] Only the paragraphs of Kanellopoulos' Wood work are mentioned, since the translated text is more extensive compared to Tsakakis Wood work.

Treatise of Descriptive Geometry could lead to the assumption that the common French handbook might be Leroy's Stereotomy edition 1844. The presentation of the various applications, at least as it appears in the title *Traité de stéréotomie comprenant les applications de la Géométrie Descriptive á la théorie des ombres, la perspective linéaire, la gnomonique, la coupe des pierres et la charpenter*, has the same layout as the translations of the Greek books (increasing numbers of the paragraphs of the translations). The references to Descriptive Geometry made by Tsakakis in his translation of the courses of Scenography [95, 3 and 41], and by Kanellopoulos in the courses of Shades and Shadows [42, 5 and 7] refer to Leroy's Treatise of Descriptive Geometry.

4 Professors of Descriptive Geometry

4.1 Professors of Descriptive Geometry at the Military Academy

For a long time, the appointed professor of Descriptive Geometry in the Military School of Evelpides was a military officer of Engineers, **Dimitrios Stavridis** (1803-1866). His elementary education took place in a Greek school of his homeland. Initially he was admitted in the Medical University of Vienna. After a while he abandoned this field and he was admitted in the Technical University of Vienna not only due to his natural inclination towards Mathematics, but also because he believed that he could offer more in Greece. He stayed in Vienna for a total of nine years (1818 - 1827) and finally received the degree of *Docteur Ingénieur Architecte.* The courses he was taught were: Mathematics, Physics, Chemistry, Geodesy, Topography, Astronomy, Architectural Design and Elements of Construction. He returned to Greece in 1828 and joined the military camp of Dragamestou. The same year, in April, he was appointed assistant of colonel Theodore Vallianos (1796-1857), whose main objective was the construction of the Orphanage building. With the decree of 28 July 1829 "the military corps of

Fortification and Architecture was established", in which Stavridis was assigned with the rank of lieutenant. In 1829 he was positioned in the Military School[82] . In March 1832, the deputy commander of the Military Academy, Konstantinos Axelos, (his birth and death date remain unknown) recommended him for the position of professor of Practical Mathematics[83]; the recommendation was approved by the Governor (Augustine Kapodistrias).

At the same time, he probably taught Technical Drawing and the course of Civil Buildings. According to a list of professors of the School published later on (1839), Stavridis taught Architecture, Descriptive Geometry and Civil Construction. He translated many technical terms[84] from Architecture, Mechanics and Descriptive Geometry [102, 336] into Greek. It is possible that the term Parastatiki Geometria (Descriptive Geometry) should be attributed to him. He was probably inspired by the equivalent German term as he had studied in a German-speaking Technical University. The reason for not publishing books of Descriptive Geometry was probably due to the Greek country's general weakness regarding book publications[85]. Stavridis served at the Military Academy for 23 consequent years. In 1843 he undertook the duties of deputy commander and in 1855 he was appointed commander of the Military School of Evelpides (Military Academy). From 1856 up to his death he was the head of the military corps of Engineers. The

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[82] The director of the School, lieutenant colonel Pauzié recognized his value and the specialized knowledge that he had acquired in Vienna. By writing a letter to the Governor he asked for Stavridis to teach Drawing in the Central Martial School. Kapodistrias accepted the application and in November 1829 made him inspector of the School.

[83] Given the type of Stravidis' studies and the fact that he was placed in the School during the first operation of the first (biggest) class, it is speculated that Practical Mathematics included Mathematic Mechanics and Descriptive Geometry.

[84] During the 19th century, many technical terms should be attributed to the army. Military needs led to the publishing of many technical handbooks that were used for utilitarian or educational reasons. The need for technical handbooks in the army was great and so was the creation of technical terms. A list of military publications is given in [102, 329-344].

[85] This is also the main reason why a Greek translation of Monge's Descriptive Geometry does not exist, even if the classes in the Military Academy were held according to his book.

military officer of Artillery, Sofianos, who taught Mathematics for a long time in the Military Academy, was probably the successor of Stavridis. At the same time, he taught Descriptive Geometry until 1866. In 1863 the second lieutenant Souliotis was appointed professor of this course but the order was soon recalled, hence Sofianos continued teaching Descriptive [141].

Michael Sofianos (1811-1887) was born in Constantinople. He left his hometown early in order to save his life from the Turks during the Greek Revolution in 1821. Initially he went to Naxos and then to Zakynthos where he studied in a local school. On the 18th of August 1828 he was admitted to the Central Military School (Military Academy). Right from the very beginning he showed his inclination towards Mathematics. After his graduation from the Academy as a second lieutenant he remained in the Central Military School initially as adjutant, while at the same time he was assigned to teach Elementary Mathematics. Captain Axelos (deputy commander of the Military Academy with duties of commander) recommended Sofianos to become a lecturer (répétiteur) of practical and theoretical Mathematics. In 1854 he returned to the Military Academy replacing the professor of Mathematics of the School. He taught Mathematics that included a part of Descriptive Geometry until 1866 when he was replaced by the second lieutenant of Engineers Nikolaidis Nikolaos (1839-1882) [104, 199], who later became professor at the University of Athens. Later on, in 1878, he was recommended to teach Descriptive Geometry in the Technical University, but that proposal was rejected probably because of his advanced age. In the Military Academy he also taught Fortification and Artillery Construction.

He initially published the temporary and permanent fortification and Artillery Construction and later on a complete series of Mathematics more specifically:

2.2 1857, *Courses of Analytic Geometry*: Printing-house Antoniadis, Athens, 2.3 1858, *Courses of Differential and Integral Calculus*: Printing-house Antoniadis, Athens [86]

2.4 1859, *Courses of Algebra*: Printing-house Antoniadis, Athens

2.5 1864, *Courses of Arithmetic*: Printing-house Antoniadis, Athens

2.6 1856, *Courses of Tine and spherical Trigonometry* (the second publication, 1871): Printing-house Antoniadis, Athens.

As it is mentioned in the prefaces, all the above-mentioned books were used as educational handbooks in the Military Academy. Sofianos also wrote *the Treatise on Timetable,* Athens, 1857. He covered his lack of a broad mathematic education by self-studying. He retired a few years prior to his death having the rank of Major General. In 1866 Sofianos was succeeded in the course of Descriptive Geometry by captain of Engineers Leonidas Pagkalos (1824-1879) [105, 254].

From the publication of Descriptive Geometry tables (atlas) it appears that in 1881 professor of that course was Theodoros Limpritis (1846-1928). He was born in the island of Syros. His origin, however, was from Heraklion, Crete. In 1867, he graduated from the Military School of Evelpides with the rank of warrant officer of military engineers[87]. During 1902 he was minister of Military Affairs[88] and he was repeatedly elected as a member of the Greek Parliament. In 1910, he retired having the rank of Major General. [99 vol 4, 417; 142].

Miltiadis Kanellopoulos succeeded Limpritis (1843-1885). He was born in Olympia and studied in the Military School of Evelpides from which he graduated in 1861 as a warrant officer of engineers. He reached the rank of major and probably passed away while he was still a professor at the Military Academy.

It seems highly probable that Limpritis came back because of the publication and reprints of his book and because of Kanellopoulos' death. At the same time

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[86] This book was the first monograph on Differential and Integral Calculus in Greece.

[87] He remained garrison commander of Piraeus and governor of the constitution of Engineer. He participated in the war of 1897.

[88] In 1911 he became minister of the Cretan State.

with Limpritis, it appears that captain Theodoros Tsakakis (1859 -?) was also positioned as professor of Descriptive Geometry for the preliminary cources. He was born in Patras and he studied in the Military School of Evelpides from which he graduated in 1877 having the rank of warrant officer of Artillery. He participated in the war against the Turks in 1897 and retired in 1909 having the rank of lieutenant colonel. George Stournaras (1859 -?) was probably called in to fulfill the need of teaching Isometric Projections and Gnomonic projection. He was born in Aetoliko and also participated in the war against the Turks in 1897. He retired in 1919 with the rank of colonel of Artillery.

4.2 Professors of Descriptive Geometry at the Naval Academy

The only known professor of the 19th century was Konstantinos Petalas (1854 -?). He was born in Patra. In 1877 he graduated from the Military School of Evelpides[89] as warrant officer of Artillery [24, 33]. He was repeatedly elected as member of the Parliament and he retired in 1914 having the rank of Major General [99 5, 313].

4.3 Professors of Descriptive Geometry at the Technical University

The first professor of Descriptive Geometry at the Technical University was Ioannis Papadakis (1825 –1876). He was born in Crete and studied at the École Polytechnique. The university employed him for the winter term of 1850- 1851 as a fellow professor of Mathematics and Astronomy. In 1952 he was promoted to honorary and in 1852 to full time.

He taught at the University of Athens from 1850 up to 1867, during which he moved to Crete in order to enforce the Cretan fight. He was professor of

[89] He participated in the Unlucky War and in the Balkan Wars.

Descriptive Geometry in the School of Arts (precursor of the Technical University) from 1853 up to 1856. In 1856 he resigned from this position. In 1863, he came back to the Technical University where he taught Descriptive Geometry until his death. During the period of Papadakis' voluntarily removal, a P. Pilotos for whom no biographical information exists, taught the course of Descriptive Geometry. After his death in 1876, Papadakis was succeeded by **Dimitrios Tournakis** (1820-1902) who was born in Corinth. In 1836 he was admitted in the Military School of Evelpides from which he graduated in 1844 as a warrant officer of the Artillery. He served in the Λόχος Τεχνιτών (Company of Craftsmen) and at the same time he was a tutor at the School of Craftsmen of Armory[90]. As captain he served in the Military School of Evelpides. From January 1877 up to February 1878 he taught Descriptive Geometry in the School of Arts[91]. [47, 248].

In 1878 Tournakis was succeeded by Nikolaos Solomos (1840 -) who only taught for a limited time. He was born in Patras and studied in the Military School of Evelpides from which he graduated in 1864, as a warrant officer of Engineer. In 1876, he was appointed professor of Trigonometry and Analysis in the School of Arts, where he taught these courses until his removal in 1877. In 1878 he was re-appointed and taught Descriptive Geometry for eleven months. In 1878 he retired as a major and then joined the newly established service of Public Work as a state-employed civil engineer [73, 514- 515]. The same year, Andreas Zinopoulos (?-1890) who had studied engineering in the Central Faculty of Arts and Professions in Paris, took over. In 1878 he came to Greece and was appointed state-employed civil engineer in the service of Public Works. He taught Descriptive Geometry from 1878 up to 1882. [73, 517].

In 1882, Apostlolos Apostolou (1842-1918) undertook the chair of Descriptive Geometry. He was born in Monemvasia and he studied in the Military

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90 As far as level classification is concerned, the School of Craftsmen could be classified in the lower technical education.

91 He was deputy of province (Corinthian). He retired on July 22, 1890 having the rank of Major General.

School of Evelpides from which he graduated in 1863 as a warrant officer of the Engineer. He was professor of Descriptive Geometry at the Technical University for the period 1882 up to 1905. At the same time he was professor of Topography at the Military School of Evelpides [92]. Apart from the books of Descriptive Geometry he also wrote *the Courses of Topography* [1883]. He participated in the war against the Turks in 1897 and was retired in 1905 having the rank of colonel. [99 2, 414; 73, 520]. Loizos Lantsas (1854- 1919) taught Perspective at the same time as Apostolou [73, 279][93]. He studied Painting in the School of Arts and was specialized in Perspective. In 1883 he was appointed as non-paid professor of Perspective and Architectural Designing in the School of Arts. In 1887 he became assistant of Technical designing and remained in this position up to 1917. [73, 521-522].

4.4 Professors of Descriptive Geometry at the Military Faculty of Non-commissioned officers

The first professor of Descriptive Geometry at the Faculty of Non-commissioned officers was Telos Moshopoulos (1847-?). He studied in the Military School of Evelpides from which he graduated in 1869 as a warrant officer of the Engineer. He was professor of Bridge and Road Constructions in the Military School of Evelpides[94] [98]. [99 4, 663; 142]. Moshopoulos was probably succeeded by **Patroklos Kontogiannis (1862-1943)**. He studied in the Military

[92] He participated in the war of 1897. He retired in 1905 having the rank of colonel.
[93] He was the son of Italian originating Vikentios Lantsa (1822-1902), who came to Greece in 1848 chased from the Austrians. Cf.: [69, 278].
[94] He is the founder of the storage rooms of War Material in Athens and in Piraeus. He was personnel manager for the ministry of military affairs. He participated in the war 1897 as commander in a battalion. He retired in 1910 having the rank of Major General.

School of Evelpides from which he graduated in 1883 as a second lieutenant of the Engineer. He served in the topographic department of the Army[95].

He spoke both French and German fluently. During a two-year period he completed his studies [140] in 1892 in Austria (Constitution of Engineer and Geographic Institute) and in 1911 in France (School of War) [100, 138].

5 Conclusions

The opinions during the dominion of the Byzantine Empire, especially about religious art, created various scientific obstacles in the growth of drawing in the Greek region. Perspective and the Shades and Shadows were rejected. Later on, several conservative circles of the Orthodox Church did not accept the Enlightenment [63, 91-116], which resulted to serious objections in scientific achievements (air balloon, heliocentric system, etc)[96]. The above ideological obstacles appear to be exceeded after the revolution of 1821, the predominance of the westerners in Greece (Kapodistrias, Fanariotes, etc), but also after the arrival of Otto who imposed the European models very swiftly. It is not accidental that during Otto's reign, Athens, an ancient Greek city was selected as the capital of the Modern Greek State. Even from early revolutionary time, it was clear that there was a great need for Greece to educate as many people as possible in drawing, which was taught even in elementary education. The drawing that was taught in the mutual-learning schools was considered elementary, so Francoeur's teaching of Linear Drawing was translated and constituted a high priority work for the newly established state. This translation of Francoeur's work was considered

[95] He was a military attaché in Constantinople for a decade (1899-1909). He participated in the wars of 1897, of 1912-13 (Balkan war) and of 1917-1921. During the Balkan wars 1912-1913 he was the head of Military Staff. He retired in 1921 having the rank of lieutenant general.

[96] For the course of the Modern Greek mathematic education after the fall of Byzantium cf.: [49, 2001].

essential for the education of craftsmen. The establishment for elementary education in Greece was initially the Orphanage and later the informal technical school that was organized for the needs of Arsenal (the technical association of that period)[97]. Greek Education and especially military education was based on French models. As a result, high importance was given to Descriptive Geometry, which constituted a basic scientific means of communication between the technical sciences and the craftsmen. Initially, at least in France, this course constituted the basis for academic technical education (Polytechnic Faculty, etc), while its inclusion in the Greek syllabi resulted in giving the relative educational institutions a quality of third degree education. The graduates of the Military Academy took over higher technical managerial positions and the public works. The gap between lower and higher technical personnel was exceeded by the establishment of the School of Arts. This gap was exceeded in the early post-revolutionary time by the Evelpides (those who did not want to graduate from the Military School of Evelpides) [138 HAMFA, 139]. For over a century, private constructions were manufactured by experienced artists. This resulted in creating obstacles in the advancement of a higher technical education.

The development of Descriptive Geometry in Greece was continuously growing contrary to other countries. At the Military School of Evelpides the factor of gravity of Descriptive Geometry was initially 8 in a scale from 1-10, while later it was included in courses of greater importance (factor of gravity 10).

Along with the Organizations, the establishment of a chair of Descriptive Geometry and also the increase in the teaching hours and the subject-matter was anticipated after 1864. As a traditional basis, Monge is abandoned as being dated, while contemporary authors such as Leroy or Olivier take his place instead. Descriptive Geometry did not seem to have any practical applications in Greek society. Even Stone-cutting produces obstacles because of the powerful guild of

[97] More on the provided lower technical education in the context of the army see: [14, 96-109].

lapidaries (experienced artists). The predominance of Descriptive Geometry in Greek education emerges also from the fact that it was taught in all technical educational institutions of the country.

In 1882 the first written handbooks on Descriptive Geometry were introduced in two educational institutions of that period (Military School of Evelpides, Technical University). Those handbooks had neither drawings nor exercises[98].

The army constitutes the linchpin. All the books derive from military authors, since almost all the professors were graduates of the Military School of Evelpides. The cause should primarily be looked for in the fact that technology during the 19th century was in the hands of the army and secondly in that Architecture constituted one of the basic military courses. The level of knowledge for the Military Academy, regarding Descriptive Geometry, compared to the École Polytechnique, could be placed in higher education and the remaining military faculties (Cadets and Non-commissioned officers) in secondary. The Technical University presented a tendency to continuously enforce the subject-matter with difficult meanings and problems of Descriptive, and therefore, while Apostolou's initial book included a subject-matter of secondary education, the content of the final reprints could be characterized as subject-matter for the highest level of education. In Greece as in France, technology during the 19th century was linked with the army. Up to the Balkan Wars (1912-1913), the Military School of Evelpides acted more as a Technical University and less as a military school.

[98] Except the case of Limbritis' Descriptive Geometry where part of the theory was transformed into exercises.

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[108] ΓΑΚ (a) King Otto’s Period, Examinations of Military Academy (Othoniko Arxeio, Exetaseis tis Stratiotikis Sxolis).

[109] Exams of 1848. folder 424, documents 150, 108, 157. Tests of the students

Souidas Charilaos, Markopoulos Markos (they graduated of the Military Academy in 1849) and of a third student whose name is not clearly written.

[110] 14 October 1854, folder 409, documents 62, 96, 97, 98, 100. Tests of the students I. Kokkidis, D. Sekeris, Adolph Rheineck, and N. Stergiou. All the above mentioned students (Evelpides) graduated from the Military Academy (Military School of Evelpides) in 1854.

[111] June 1857, folder 418, document 006. Exam timetable of Military Academy.

[112] June 1847, folder 374, document 079. Analytical results of the 1847 exams.

[113] June 1852, folder 404, document 069. Analytical results of the exams which were accompanied by the protocol of the Educational Council.

[114] 31 July 1842, folder 422, documents 035, 039. Test by the students Sisini and Soutsou.

[115] 27 September 1862, folder 430, documents 250, 260. Descriptive Geometry tests of the students Papabieros and Drakopoulos.

[116] 18 January 1837, folder 418, document 4. On the 5th, 6th,7th years taught courses.

[117] ΓΑΚ, (b), King Otto's Period, Organization plan of Military Academy (Othoniko Arxeio, Grammateia ton Stratiotikon, Organismos tis Stratiotikis Sxolis).

[118] 1837, folder 370, document 67. List of the Personnel of the Military Academy.

[119] 27 March 1842, folder 372. Proceedings of the Educational Council of the Military Academy.

[120] 17 March 1853, folder 375, document 026. Complaint letter of some professor regarding salary issues and development and presentation of the thesis the School by the director of studies Stavridis.

[121] 28 September 1848, folder 373, document 070. On courses of the Military

Academy. Document of the Academy commander to the Minister of Military Affairs.

[122] ΓΑΚ, (c), King Otto's Period, Library of the military Academy (Othoniko Arxeio, Bibliothiki thw Stratiotikis Sxolis).

[123] 14 March 1851, folder 44, document 045. Letter of the Minister of Foreign Affairs.

[124] 27 June 1848, folder 423, document 017. On courses taught in the Military Academy. Regarding Descriptive Geometry Stavridis states that he use as a handbook Monge's book.

[125] 1 March 1849, folder 413, document 043. The professor of Architecture comments in a three pages documents a handbook on Architecture.

[126] 18 October 1851, folder 44, document 071. Letter of the commander of the Military Academy to the Minister of Military Affair regarding lithographic books of scientific courses in France. The lithographic books were called notebooks (tetradia).

[127] 2 May 1860, folder 417, document 028. Report of the professor of the Fortification Captain Tomaropoulos.

[128] 28 October 1861 folder 417, document 112. Commander's application for the purchase handbooks.

[129] 24 Nobember 1851, folder 414, document 044. Application of the Chemistry Professor of the Military Academy officer of the corps of engineering, for the purchase of French Chemistry handbook.

[130] 4 April 1854, folder 415, document 032. Loss of the first out of three volume of a French Architecture handbook by the professor of Bridge Construction.

[131] 7 November 1861, folder 417, document 116. Application of the commander of the Military Academy for the purchase of a book on Topography and Geodesy.

[132] ΓΑΚ, (d), King Otto's Period, library of Ministry of Military Affairs

(Othoniko Arxeio. Ypourgeio Stratiotikon, Bibliothiki).

[133] 5 October 1850, folder 42, document 102. Return of an Architecture handbook which was loaned to the Military Academy.

[134] Without date, folder 42, document 008. List of essential books for the library of the Ministry of the Military Affairs.

[135] ΓΑΚ, (e) Βλαχογιάννη Γραμματεία Στρατιωτικών-Ναυτικών (Vlachoyannis collection: Department of Army & Navy).

[136] January 1829, folder 102, document 54. Organization of the Military Academy.

[137] ΓΑΚ, (f), General Secretariat (Geniki Grammateia).

[138] 22 May 1827, folder 196. Karadinos' statement regarding the publication of his mathematics' books.

HAMFA Ιστορικό Αρχείο Υπουργείου Εξωτερικών (Historical Archives of Foreign Affairs)

[139] 24 May 1832, folder 95, document 1. Manuscript concerning the architect Kleanthis and colonel Schaubert, who were responsible for composing the plan of Athens.

[140] 21 June 1832, folder 95 document 1. From this document, it is apparent that the architects asked the Evelpides (Cadets) to measure Greek territory and especially the high grounds.

Υπηρεσία Στρατιωτικών Αρχείων (ΥΣΑ) (Military Archives Service)

[141] Personal Record of military officer of engineering corps Kontogiannis Patroklos No 285.

[142] Order of the Days of the Military Academy, Δέμα 4-4 ¼ , Film 4-Φ, 54-Θ.Λ.

[143] 100 years of the Naval Academy (Sxoli Nautikon Dokimon) 1984: Naval Academy, Piraeus.

Army History Directorate Biographical Notes of Army Officers (Biografika simeiomata Dieuthinsi Istorias Stratou)

[144] Army History Directorate Biographical Notes of Army Officers