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PRESENTATION OF DESCRIPTIVE GEOMETRY AS A NEW FIELD OF SCIENCE BY F. SAPALSKI IN CRACOW SCIENTIFIC SOCIETY ON 16TH NOVEMBER 1817

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Abstract. In this paper we present the key points of the public address of F. Sapalski at the Cracow Scientific Society on 16 November 1817. F. Sapalski presenting the essence of the new science, descriptive geometry, refers in his speech to the practical benefits of its application in art, science, construction, architecture etc. An important element is also the assessment of the impact of descriptive geometry on the socio – economic development of the country. The author thus becomes the proponent of the idea of shaping the social being through the development of modern technical education.

Keywords: Franciszek Sapalski, Descriptive Geometry, applications, algebra, stereotomia.

„La geometrie descriptive devant devenir un jour une des parties principales de l'education national, parce que le methods qu'elle donne, sont aussi necesseaires aux artistes, gue le sont la lecture, l'ecriture et l'arithmetique" – G.Monge (Geometrie Descriptive p.111) [1]

1 The life and works of Franciszek Sapalski

Franciszek Sapalski was born on 1st April 1791 in Warsaw. He graduated from the famous Krzemieniec High School. In 1809 he began to work in the Ministry of Public Income and Treasury. He possessed outstanding mathematical skills which he decided to use during his military service. In 1810 he joined the ranks of the armed forces of the Warsaw Grand Duchy as an artillery sergeant. After graduation from a military school of artillery and military engineers he was promptly promoted to the rank of second lieutenant and next to lieutenant. During the time of his military service he began his work on writing Descriptive Geometry textbook and attends, as a private person, lectures by Jan Joachim Liwet – first professor of the subject at application school of the Warsaw Grand Duchy. In 1812 he submitted a concept behind the first, written in the polish language, textbook on Descriptive Geometry, for assessment of Society of Friends of Sciences in Warsaw. Unfortunately, the work was not completed because in 1812 he took part as an adjutant major in the Napoleonic Campaign. In 1813 he left the army because of bad health and devoted himself to scientific career. Then he goes to Paris attending public lectures on: mathematics given by Lacroix, optics by Biot, physics by Gay – Lussac, chemistry by Thenard, astronomy by Delambre and Argo and mechanics by Poisson. Having obtained support from the Russian ambassador count Pozzo di Bordo he started studying Descriptive Geometry at polytechnic institute (l'Ecole Politechnique) under Hachett. In 1816 he was appointed deputy professor of Descriptive Geometry and Mechanics at the Jagellonian University (UJ). In the same year he becomes a member of Cracow Scientific Society. In November 1817 he prepared a scientific treatise on

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"Stereotomia or Descriptive Geometry Theory". As a result of the treatise F. Sapalski was appointed regular professor of Descriptive Geometry and Mechanics at the Jagellonian University. Till 1833 he gives lectures in Polish and then goes into retirement. At that time he holds numerous scientific and civic offices. In 1820 he is elected as a representative of UJ to Assembly of National Representation and in 1823 takes up the post of the Dean of Faculty of Mathematics at UJ. In 1824 he becomes a corresponding member of Warsaw Scientific Society and a year later he is appointed Senator at the Ruling Senate of Free City of Cracow. In 1822 he publishes the first volume of his work "Descriptive Geometry". For this work he is rewarded with a diamond ring by Tsar Alexander I. He dies on April 2, 1838 in Cracow [2,4].

Figure1: Franciszek Sapalski - lithography (1838) [3]

In this paper we present the key points of the public address of F. Sapalski at the Cracow Scientific Society on 16th November 1817. In our opinion, the presentation of F. Sapalski is very interesting because of the universal message concerning the importance of descriptive geometry in the modern technical education.

2 Apotheosis of mathematics and geometry in human development (p. 4-10)

2.1 Ontological significance of development of mathematics and geometry

In the introduction to the treatise "Stereotomia or Descriptive Geometry Theory" F. Sapalski presented the impact of mathematics and geometry on the development of human personality, and thus the formation of civilization. This concept of some ontological assumption is very interesting. The presented formula: mathematics (knowledge) – personality (mind) – creation of reality (development) becomes for Sapalski a real element shaping the environment of man. The presented apotheosis of mathematics and geometry allows to assess its impact on human development. The advantages of mathematics are defined in two ways. Firstly – organizing mind which "creates in everyone relevance, attention, order, keen intelligence and profound

thought". Secondly – introduces calculation, the notion of size, "searches for the truth and reason, gives the principles, explores and shows the similarity and dissimilarity of things". It draws attention to the relationship between mathematics and geometry, relations which determine the knowledge of all areas of science (physics, astronomy, optics, mechanics etc.).

2.2 Effect of algebra to geometry (p. 23 – 25)

F.Sapalski appreciates the great impact of Euler and Legrand's scientific works on understanding and discovery of many geometrical issues. Analysis of the different geometric problems based on accounting methods helped Euler and Legrand to define general issues. The influence of the accounting methods determined the development of *stereotomia.* First of all it concerned the adaptation of "calculation to the line and curved surfaces", based on the mathematical properties and methods to create them. By this, geometry has become a synthetic science and the development of algebra allowed to develop graphic methods for saving geometric constructions.

3 *Stereotomia* and the emergence and development of descriptive geometry

3.1 *Stereotomia* or "art of drawing" - creation of descriptive geometry (p.10–13)

Drawing, in other words graphic representation of the elements of nature, is for Sapalski the essence of creative work. The introduction of the theory of projections and the recording of constructions allows for a clear method of description of spatial phenomena. The definition of the recording of spatial forms on a flat drawing resulted in "separate skill under the name of Descriptive Geometry or skill of projections". This is a definitive end of *stereotomia* based on implicitly and studies of individual spatial problems in isolation from the general method. The above two aspects of the new science i.e. record of constructions in architecture, mechanics, visual arts etc., and analysis of spatial form, decide on the practical use of descriptive geometry.

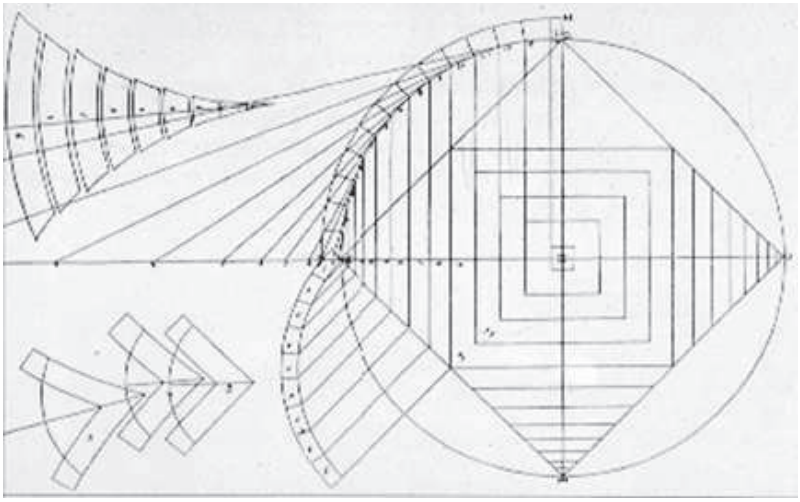

Figure 2: Philibert de l'Orme: Development drawing of dome on pendentives" *The First Volume on Architekture"* (1567) [5]

3.2 History of development of *stereotomia* (p. 14-21)

F.Sapalski in his work relates to development of *stereotomia* from antiquity to modern times. His analysis is based on examples of architecture and building engineering. He pays particular attention to the lack of a method for the analysis of geometric construction problems. The basis of the works was experience. F. Sapalski justifies the little interest in grafhical methods to solve spatial problems by the lack of the need to seek the substance of the problem. He

critically examines the scientific studies arising from the sixteenth to the eighteenth century. The works of Philibert de l'Orme, Mathurin Jousse, Francois Derand, Jean-Baptiste de-La-Rue, Amedee-Francois Frezier or Abraham Bosse developed construction and graphical issues. Despite the sometimes rigorous analysis they did not give answers to the core question concerning the issues of recording the construction and the use of graphical methods for solving geometric problems. Sapalski draws attention to the cause of misinterpretation of geometric problems. It is the analysis of practical cases rather than theoretical research. The scope of works determined by their applications such as carpentry, masonry and other crafts decided of insularity of the studies (technical terminology) and the lack of response to the general geometric problems. This is a critical analysis of the works on geometry in the context of the research methodology of geometric analysis.

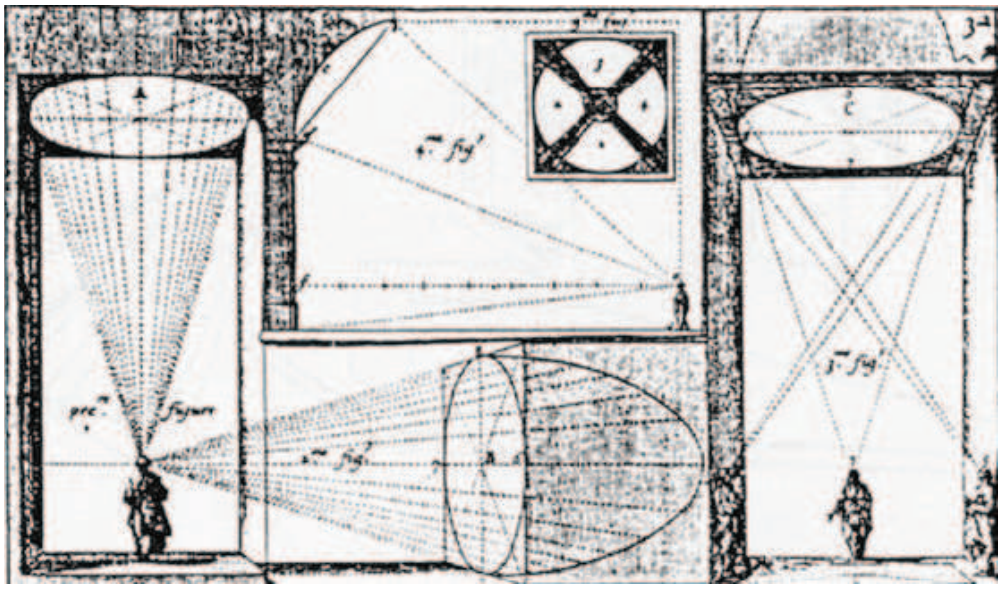

Figure 3: The national treatment of perspective "Moyen Universal de pratiquer sur les tableaux, ou les surfaces irregulieres" (A. Bosse 1653) [6]

3.3 Establishment of descriptive geometry (p. 25-32)

Apotheosis of creativity and works by G. Monge is the basis for the critical analysis of the first research and studies on descriptive geometry. The contemporary theory of *stereotomia*, through research and analysis of geometric problems in applications such as building engineering, surveying, fine arts and mechanics, developed by G. Monge, is converted into descriptive geometry ("retrieved from mechanism of debris, superstition and prejudice").The basis for the works of G. Monge became the application of analysis to solve geometric problems. F. Sapalski clearly believes G. Monge as "the creator of descriptive geometry". The originality, brevity, conciseness, exquisite style and clarity", this is what features the works of G. Monge and distinguishes his studies and publications from contemporary scientists going in for descriptive geometry. In particular, attention is drawn to critical analysis of research works by J. N. P. Hachett (there are no solutions and practical applications) and Lacroix ("Completion of the beginnings of Geometry"), where he attempts to combine theories of projection with the elementary geometry. In the paper by Lacroix F. Sapalski sees numerous errors but not in a scientific theory, but above all in the absence of a clear description of the various geometric constructions and in the order in presenting the issues and publishing mistakes (competition with the Monge method). According to Carnot ("Positional Geometry") descriptive geometry becomes a separate field of science. It is just in

combination of theoretical issues and graphic applications that F. Sapalski sees the beginning and the distinctiveness of the new field of science. “For Descriptive Geometry introduces obviousness in any, even the most complex operation of Algebra, by which is generally characterized, and mutually, Algebra adds generality to Descriptive Geometry, which is its characteristic” [1]. Parallel to the works by Monge appears a paper entitled “Drawing Geometry Lecture” by M. Poitier (St. Petersburg, published in Polish in Vilnius in the year 1807). This is probably the earliest work on descriptive geometry published in Polish. F. Sapalski who read this study concludes that the presented issues are difficult to implement for practical applications because they require knowledge of the foundations of geometry and mathematics.

4 Practical applications of descriptive geometry

4.1 The essence of descriptive geometry and its impact on practical applications (p. 32-34)

F. Sapalski recognizes the special importance of descriptive geometry in the educational process. The advantage of this science is the order and visual presentation of the constructions and the relationship among geometric issues. The end results are practical applications. Thus, the essence of descriptive geometry is its generality and the basis for solutions of spatial problems – analysis which is shaping algorithm in all artistic fields, handicrafts and mechanics. It also introduces elements of algebra to design, painting, mechanics and building engineering as well as allows to solve graphically all spatial problems „adapted to Masonry, Carpentry, Shading, Perspective, making cards and plans, Leveling, simple Machines, major complex Machines for the Roads, Bridges, Channels, Navy, Architecture”.

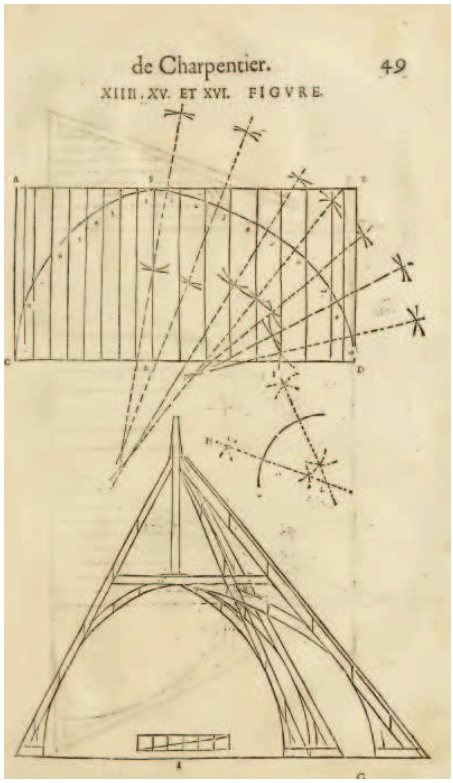

Figure 4: Mathurin Jousse “Le theatre del’art de Chanrpentier” (1627) [7]

4.2 Theory and practice (p. 22-23)

According to F. Sapalski every geometrical problem consists of two elements: the first, theoretical – from the analysis of fundamental issues to the solution of a concrete case, and the second – a practical application based on the analysis undertaken. The problem with the scientific works of the authors dealing with the issues of geometry (stereotomia) lies in the fact that in their studies they do not perceive the substance of the issues, moreover they are not able to describe the bases and" have no good knowledge of general properties of figures as an essential principle of the graphic method". The lack of this knowledge is the foundation of the mistakes made in their studies The works are not logical and lead to a lack of structural connections in geometric issues.

4.3 Building engineering and geometry (p. 35-40)

F. Sapalski as a military engineer was a builder and architect (among others, he designed the Kosciuszko Mound in Krakow, together with Szczepan Humbert). It is therefore no surprise to his particular predilection for descriptive geometry applications in construction and architecture. "Excellence, durability and economy are the hallmarks of modern construction. Geometry combines practice and theory, makes it possible to solve the most difficult construction problems and provides a method to resolve them. Sapalski draws attention to the combination of constructional mechanics with drawing methods which allow to describe graphically the solution of issues of building and construction (vaults). Descriptive geometry can be used to describe a general method for the specific construction problems. The collapse of the stairs on the terrace of the Royal Castle in Warsaw is an example of design errors, not material. Masonry is the use of solid angles whereas carpentry and transfer of construction dimensions to the wooden elements is the inverse of projective structure.

4.4 Art of painting and geometry. Arts and crafts (p. 40-43)

F. Sapalski presents the philosophy of creation and perception of a painting. He clearly separates the aesthetic realm from the theoretical grounds allowing perspective construction of the image. These two worlds are complementary. Descriptive geometry is a theoretical basis for the analysis of spatial artwork and present concrete constructional solutions particularly „beautiful and easy means of determining the dividing line of light from the shadows". Graphics, which is the art of point, line and curve (copperplate engraving) obtains its perfection through the knowledge of descriptive geometry, especially the perspective.

4.5 Military engineering and geometry (p. 43-44)

The basis of military engineering is the knowledge of curved surfaces and tangent planes. Therefore, descriptive geometry is the foundation of all military facilities. Descriptive geometry is a general knowledge. It presents a method to record the construction of three-dimensional figure based on the phenomenon in general form. Detailed solutions arise because of practical applications. "What is the grammar for the language, the descriptive geometry is for all construction works".

5 Teaching descriptive geometry in the process of social development

5.1 Knowledge of geometry and the shaping of a creative personality (p. 44-46)

Giving concrete examples of the impact of knowledge of the principles of descriptive geometry to art, construction and various fields of engineering, the author shows the development of creative personality. In particular, he draws attention to the elimination of stereotypes in the creation of artistic form, and the possibility of a correct assessment of reality resulting from the understanding of the principles of relations between spatial form and its image on a flat drawing. This allows the elimination of errors, determines the evaluation of the correctness of one's own work and eliminates the mechanical and mindless acceptance

of nature and its image. It also forms the creative personality through a critical assessment of one's own work.

5.2 Geometry and the education and development of the country (p. 46-50)

F. Sapalski definitely calls for the method of Monge to education. In his concept he refers to the pro-state activities. He sees the impact of the new field of science the development of Polish industry and innovation. According to the author social development is possible due to the introduction of modern technical education. He postulates that „at each Academy of philosophy to open a school of public works designed for the purpose of industry, inventions" and is an advocate of organic work and a pragmatist. Sapalski recognizes the importance of developing the country by applying new scientific disciplines in practice.

6 Conclusions

Presented by F. Sapalski dissertation entitled „*Rozprawa o teorii stereotomii czyli geometryi wykreślney" (Discourse on the theory of stereotomia that is descriptive geometry)* in the Cracow Scientific Society on 16th November 1817 is the first public presentation of descriptive geometry as a new field of science. The presentation is a popular science. The consequence of this is the author's reference to the variety of topics including algebra, structural mechanics, fine arts, education and economics. The author attempts to present a theoretical and practical importance of descriptive geometry. In this sense the author is a popularizer of science. The F. Sapalski's multi - argument during presentation is noteworthy. This is an example of a careful analysis of the history of search of a mapping method of space on a flat drawing combined with the pragmatics of applications. In addition, note the mental side of human personality development, resulting from the analysis of spatial and geometric forms. This aspect of the F. Sapalski's presentation is particularly interesting. Presented by the author the advantages of the new field of science – descriptive geometry, despite the passage of two hundred years, are equally valid today.

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PREZENTACJA GEOMETRII WYKREŚLNEJ JAKO NOWEJ DZIEDZINY NAUKI PRZEDSTAWIONA PRZEZ F. SAPALSKIEGO W TOWARZYSTWIE NAUKOWYM KRAKOWSKIM 16 LISTOPADA 1817 ROKU

W artykule przedstawiono zasadnicze tezy, pierwszego publicznego, wystąpienia F. Sapalskiego w Krakowskim Towarzystwie Naukowym w dniu 16 listopada 1817 roku. F. Sapalski prezentując istotę nowej nauki, geometrii wykreślnej, odnosi się w swoim wystąpieniu do praktycznych korzyści wynikających z jej stosowania w sztuce, nauce, budownictwie, architekturze itp. Ważnym elementem jest także ocena wpływu geometrii wykreślnej na rozwój społeczno-ekonomiczny kraju. Autor przez to staje się także propagatorem idei kształtowania bytu społecznego poprzez rozwijanie nowoczesnej edukacji technicznej.