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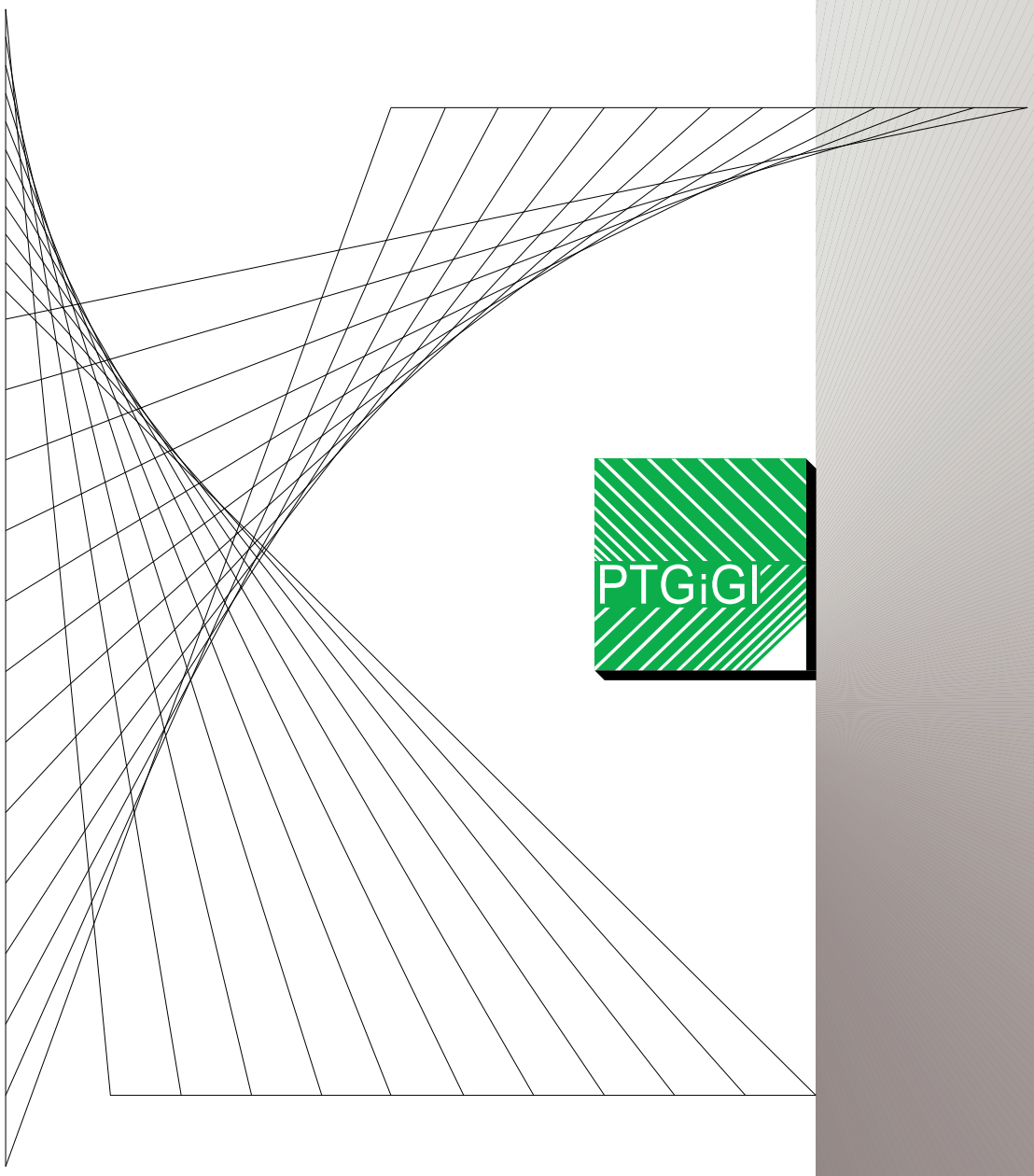

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GASPARD MONGE – THE RENAISSANCE MAN

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Abstract. An outstanding eighteenth-century French scientist, Gaspard Monge is considered the creator of descriptive geometry. Named after their creator, Monge's projections make him familiar at technical universities where the subject is taught. This article presents (in chronological order) Gaspard Monge as a scientist, educator, politician, multi-talented man, or in brief as 'the Renaissance man'. Being a scholar, he set forth both teaching standards and requirements that the technical educational institutions had to satisfy then and that still apply today**.**

Keywords: Gaspard Monge, the history of descriptive geometry

1 Introduction

Modern technical universities and their staff are faced with many challenges in an increasingly demanding work environment. This includes their teaching and research activities and concerns fields of science such as computer science, economics, pedagogy and the particular discipline that the scientist specialises in, to name but a few. The requirements include:

- ability to carry out teaching activity (it requires a course in teaching),
- ability to conduct independent scientific research,
- knowledge of specialised computer software,
- ability to use specialised equipment,
- knowledge of foreign languages (preferably English),
- ability to prepare, implement and settle contracts and research projects,
- knowledge of administrative rules and procedures,
- other.

In the light of the above requirements, Gaspard Monge will be discussed in terms of the standards that he set forth for teaching and research activities, which to this day, are still in operation in colleges and universities.

2 Gaspard Monge - The Renaissance Man

Subsequent phases of Gaspard Monge's life are shown in chronological order. We present his profile as well as his extensive interests, scientific expertise and public activity.

Gaspard Monge was born on 10th May 1746 in Beaune (Burgundy), into a family of a small merchant. He had a sister Madeleine who was a year older than him and three younger brothers – Louis, Germain and Jean[1]. Incredible as it seems, his father, despite his working class status managed to provide education to three of his sons so that each of them became a prominent scientist (Gaspard, Louis, Jean).

[1] M. Louis *Généalogie de la famille de Gaspard Monge*, Dijon-Paris, 1904.

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Gaspard Monge started his education at the *Collège des Oratoriens* in Beaune. He was an extremely gifted pupil, as evidenced by the fact that his thesis (26-page book), which he wrote as a 16-year-old (in 1762) has been kept up to this day in the town hall in Beaune.

After graduating from the high school in Beaune, he continued his education at the Collège de la Trinité in Lyon during the period 1762-1764, and as early as at the age of 17, he started teaching activities with students. When during the holidays of 1764 he and his friend drew the plan of the hometown, it became a turning point in his life. The plan got into the hands of one of the officers of an elite school for officers, École Royale du Génie in Mézières, who recommended him to the school's commandant. As a result, in 1765 he was employed as a draughtsman in the department involved in the construction of fortifications. A year later, Gaspard was given an assignment that not only demonstrated his mathematical abilities but also his geometrical genius. He was asked to design the plan of a fortification that would most effectively protect against artillery fire[2]. To do so, at that time, a very time-consuming arithmetical process had to be employed to produce a satisfactory solution. Monge with his brand new geometrical method was able to shorten that process and obtain a desirable solution considerably faster. Consequently, he completed his assignment very quickly and at first the commandant refused to accept the project. However, an in-depth analysis revealed that this new method was so effective that for military reasons it had to be kept secret. It was yet another key moment in Monge's life as it became apparent that he possessed exceptional skills in solving problems, not only in terms of theory but of engineering as well. Thus, at the early stage of his life, Gaspard Monge revealed himself as a man who was able to marry **geometry** with **engineering** perfectly combining science with practice.

At the École Royale, Monge was encouraged to perfect his skills in geometry, especially by the professor of mathematics, Charles Bossut. Becoming a member of the Academy of Sciences, Bossut left Mézières in 1768 and Gaspard Monge was appointed to take his post. As a professor of the École Royale du Génie, he taught mathematics and physics while continuing work on issues related to descriptive geometry and the applications of partial differential equations. In numerous scientific papers he discussed issues that involved mathematics, physics, optics and chemistry. Among others, he designed embankments, whose curvature he determined using differential calculus. In 1777 Monge married Cathérine Huart, who brought in a dowry in a form of a metallurgical plant which under Monge's management was modernised and improved. Later, that experience from the plant management period resulted in Monge's guide on metallurgy and the cannon manufacturing industry. This stage of his life showed Monge's versatility, both scientific as well as organisational. His competences were revealed in disciplines such as **mathematics, physics, chemistry and writing of scientific papers,** together with organisational skills in **managing an industrial plant.**

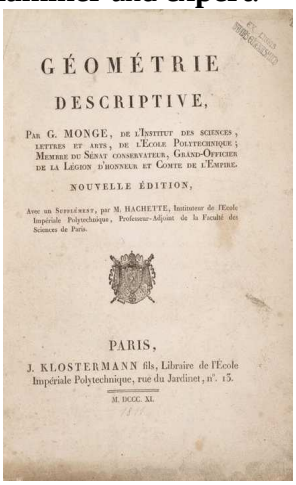
In 1780 Gaspard Monge became a member of the Academy of Sciences and within the scope of this function he lectured in hydrodynamics at the Institute that used to be run by Charles Bossut and participated in projects in the field of physics and chemistry. He divided his time between Paris and Mézières, working half a year in the former and the other half in the latter. However, after three years, he finally moved to Paris in 1783, where he took an active part in public life. From 1783 to 1789 he worked as an examiner of marine cadets. As a member of the Jacobins club, enthusiast and an active member of

[2] In *Géométrie descriptive* Gaspard Monge wrote: "If you want to build a fortification, at the beginning it should be assumed that the area within a cannons' range is horizontal and does not give any advantage to those under attack. Then the fortification should be built with walls (also taking topography into account) so that their height exceeds the height of a man (conical contact surfaces are calculated)".

the Revolution, which broke out in France in 1789, he served as the Minister of the Navy at the turn of 1792/1793. He held this post for only eight months and then he resigned after realising that he was not going to succeed in making the French fleet match the British fleet in effectiveness and performance. He moved on and took a top position in running French national arms factories, a foundry, a rolling mill and a gunpowder mill. Together with Phillippe Fabre d'Eglantine and Gilbert Romme, he was one of the initiators of the French-African revolutionary calendar[3]. He was also on the committee of weights and measures, which was developing the project of the decimal metric system. He took an active part in the establishment of the French Institute (25 October 1795)[4]. In 1796 as a member of the Science and Art Committee in Italy, he selected paintings and statues to be brought to France. Currently, many of those works are on display in the Louvre. From 1798 to 1799 he accompanied Napoleon in the Egyptian campaign. The expedition had military, economic and political aspects as well as a scientific aspect. A Commission comprised of scholars and artists that accompanied the army established the Institute of Egypt [Institut d'Égypte] modelled on the Institute of France. Monge became its president, Bonaparte its vice-president, Joseph Fourie a secretary with Louis Costaz as his assistant.[5] This period of Gaspard Monge's active life revealed him as a **politician**, **examiner** and **expert**.

Figure1: Portrait of Gaspard Monge by François-Séraphin Delpech

a)



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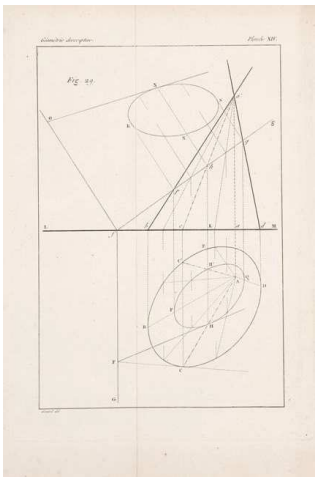


Figure 2: G. Monge *Géométrie descriptive*: front page (a), section of the cone (b)

In Paris, Monge continued his scientific and teaching activities. In 1794 and 1795 he taught at the École Normale and co-founded the École Polytechnique of which he was an

[3] Another name is the French Republican Calendar (Le **calendrier républicain** or **calendrier révolutionnaire français**). It was introduced by the Republican Convention in revolutionary France on 5 October 1793. On 9 September 1805 Napoleon Bonaparte signed the legislation restoring the Gregorian calendar from 1 January 1806. The calendar was reintroduced yet again, but for a short period, in 1871 by the Paris Commune.

[4] **Institut de France** - French science association comprised of five academic entities:

- Académie française [French Academy] – founded in 1635
- Académie des inscriptions et belles-lettres [Academy of Inscriptions and Fine Literature] – founded in 1663
- Académie des sciences [Academy of Sciences] – founded in 1666
- Académie des beaux-arts [Academy of Fine Arts] – founded in 1816
- Académie des sciences morales et politiques [Academy of Moral and Political Sciences] – founded in 1795

5 On November 22, 1799, the Institute decided to release all works, materials and studies collected during the Egyptian campaign by a team of scientists and artists accompanying Napoleon to Egypt, in a single work. It was a 24 volume epic "Description of Egypt" ("Description de l'Egypte"), which to this day is a core textbook for students on Egypt.

administrator and a teacher for over 20 years. Here, Monge was revealed as a **lecturer, co-founder of a technical educational body** and its **administrator**.

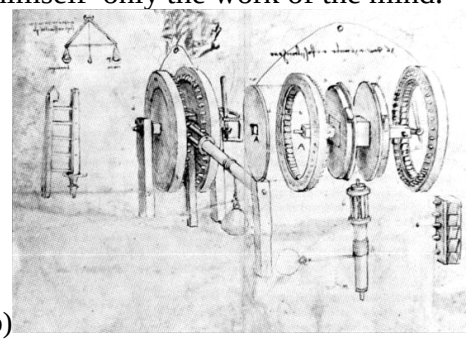
Published in 1794 in Paris, Gaspard Monge's lectures took the form of pamphlets and in 1799 his '*Géométrie descriptive*' became available in printed version. In this work, Monge gave the definition of descriptive geometry, which is still in use and valid, as the art of presenting on paper of only two dimensions geometrical objects that are of three dimensions, allowing them to be accurately described. His main achievements include the gathering of all up-to-date techniques of sketching three-dimensional objects on a two-dimensional drawing plane and systemising principles which can be applied to those techniques. His interests involved two-image mapping in rectangular projections on planes perpendicular to each other, which means that vertical and horizontal projections are both placed on one plane. Each and every spatial point is noted on a plane by two points placed on one vertical. Explicitness of notation is what distinguishes the spatial notation proposed by Gaspard Monge from those of his predecessors.

Gaspard Monge in his introduction to '*Géométrie descriptive*' wrote:

"In order to free the French nation from foreign dependence, ..., national education should be primarily directed towards the knowledge of objects that require precision, ..., and to train professionals in the use of all kinds of instruments, the purpose of which is the introduction of the accuracy of the work and the measurement of its extent. In particular, the national education will be given a required direction when our young professionals will be used to the application of **descriptive geometry** for graphic designs needed in many areas, and to use it to build and determine machine elements by which a man, harnessing the forces of nature, reserves for himself only the work of the mind." [6]


TRAITÉ ÉLÉMENTAIRE
DES MACHINES,
PAR M. HACHETTE,
INSTITUTEUR DE L'ÉCOLE IMPÉRIALE POLYTECHNIQUE.
PARIS,
SAINT-PÉTERSBOURG,
M. DCCC. XI.

a)



b)

Figure 3: J. N. Hachette *Traité élémentaire des machines*: front page (a), a mechanism (b)

Figure 4: Mausoleum of Gaspard Monge in the Le Pere Lachaise Cemetery

The above excerpt demonstrates Gaspard Monge's **humanism** and his concern about future generations and the future of his own nation, thus revealing his **patriotism**. In the world of science Monge established himself as the **father of descriptive geometry** and the inventor of **Monge's projections**.

Gaspard Monge is associated with the introduction of yet another discipline. In 1794 within the framework of a descriptive geometry course, he proposed to discuss a certain group of mechanisms and thereafter this year is regarded as the birth date of the Theory of Mechanisms and Machines (TMM). It was not until 1808, that the École Polytechnique started studies in the theory of mechanisms and machines as a separate subject. Monge's plan

[6] G.Monge *Géométrie descriptive*, Paris, 1811, Polish translation of: A.P.Juszkiewicz *Historia matematyki. Matematyka XVIII stulecia [The History of Mathematics. Mathematics of the 18th Century]*, PWN, Warszawa 1977, pp.201-202

was to publish a book on mechanisms, however due to his many engagements he was never able to do it. His plan was realised by his successor Jean Hachette. In a book issued in 1811 he presented Gaspard Monge's ideas regarding the classification and the analysis of mechanisms[7]. Hence Gaspard Monge can also be called the **inventor of the Theory of Mechanisms and Machines**.

Charles Dupin, Monge's student, wrote in his memoirs:

"It happened that Monge, wanting to be quickly with some students in a classroom, he wasted no time searching for a bridge, but without interrupting the lecture he forded a broad river, and the people around him rushed after him trying not to miss anything of what he was saying: such was his magic on them." [8]

This revealed Gaspard Monge as an extraordinary, almost **charismatic tutor.**

For his involvement in the public life of his nation, Gaspard Monge paid the highest possible price. After the fall of Napoleon Bonaparte, the Bourbons regained power. Fearing for his life Gaspard Monge left the country. On his return to Paris, he was stripped of all honors and his membership of the Institut de France was taken away. These were enough to plunge Gaspard Monge into depression and caused his death in 1818. Despite the authorities' assurances that his honors would be returned, Monge's funeral became an opportunity for paying tribute to a great man. Scholars, the officer corps, manufacturers, people of culture, and crowds of ordinary Parisians took part in the funeral. Gaspard Monge was buried in Le Pere Lachaise cemetery in Paris. After exhumation in 1989, the remains were deposited in the Pantheon.

3 Conclusions

Gaspard Monge lived in modern times. Europe was undergoing profound economic, social and cultural changes. In science and technology as well as education, a huge step forward was taking place. Europe saw big demographical growth, doubling its population, which together with industrial development contributed to the expansion of cities. Industry, which until then was mainly craft and manufacture with low efficiency and high running costs, was subject to revolutionary changes. It was a period of technology and science-oriented revolution and the emergence of numerous inventions, which facilitated the transition from a craft to factory production. As a result of industrial revolution, the bourgeoisie grew in importance due to their possession of large financial means, allowing them to have an impact on politics and bringing about revolutions; Monge took part in one of them.

The physical world at the turn of 18th and 19th century was perceived as a huge mechanism of which Galileo wrote in 1623:

"*Philosophy is written in that great book, which ever is before our eyes - I mean the universe - but we cannot understand it if we do not first learn the language and grasp the symbols in which it is written. The book is written in* ***mathematical language*** *and the symbols are* ***triangles, circles****, and other* ***geometrical figures****, without whose help it is impossible to comprehend a single word of it; without which one wanders in vain through a dark labyrinth*"[9].

Gaspard Monge is found to be fully in line with the ideas of modern times having set standards for teaching in technical universities that are still in operation today, such as:

[7] J. N. P. Hachette, *Traite elementaire des machines,* Paris 1811.

[8] Excerpt from: M. Kordos *Gaspard Monge - uczony i nauczyciel* Matematyka dawniej i dziś [Gaspard Monge – scholar and teacher [in :] Mathematics Before and Today], no.1, 2007, pp.3-8

[9] G.Galilei *La Opere*. v.VI, Firenze, 1891. P.232, Polish translation of: A.P.Juszkiewicz *Historia matematyki Tom drugi Matematyka XVII stulecia [The History of Mathematics Vol.2 Mathematics of the 17th century]*, PWN, Warszawa 1976, p. 12

- combining science with practical solutions for certain issues,
- reforming the teaching of mathematics and physics by combining theory with practical exercises (30% of classes involve practice in a manufacturing plant),
- introducing a new profession – an industrial officer, now called the engineer,
- applying mathematics to mechanics and physics by using geometrical methods,
- founding his own school, which produced many scholars. Amongst his pupils there were outstanding mathematicians: Carnot, Lacroix, Hachette, Brianchon, Ampere, Poncelet, Chasles.

Today, scholars involved in the education of young students of technical educational institutions follow standards set forth by their predecessors focused on the multi-dimensional development of the institutions devoted to science and education. Amongst those, Gaspard Monge is one of the most extraordinary as he was the founder of the very first institution of this type. Alongside his versatile scientific activity, he proved himself as being a great organiser, specifying the principles of running a technical educational institution that are up-to-date and still in operation. Gaspard Monge and his achievements are worth remembering and should be popularised amongst scholars. Not only is he a role model as a scientist and a teacher but also as a great patriot looking ahead to the future of his country.

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GASPARD MONGE – CZŁOWIEK RENESANSU

Gaspard Monge to wybitny osiemnastowieczny francuski naukowiec, uznawany za twórcę geometrii wykreślnej. Znany jest na uczelniach technicznych z racji nauczania tam rzutów Monge'a, a więc rzutów, których nazwa związana jest ściśle z ich twórcą. W artykule przedstawiono (w układzie chronologicznym) Gasparda Monge'a między innymi jako uczonego, dydaktyka, polityka, człowieka wszechstronnie uzdolnionego, jednym słowem jako człowieka renesansu. Ukazano również tę postać pod kątem wymagań stawianych obecnie pracownikom uczelni technicznych oraz standardów, które on wytyczył.