A Biography of James Watt
January 19, 1736 – August 25, 1819

James Watt was born on January 19, 1736 in Greenock, Renfrewshire, Scotland to James Watt and Agnes Muirhead. As a child, and throughout much of his early adulthood, Watt was often sick and suffered from headaches. Such setbacks pushed his family to homeschool him for much of his early development. Watt' mother, Agnes, was responsible for his early education. His father, also James, was a shipwright with refined carpeting and handyman skills. Because of his proximity to his father's workshop, Watt grew up acquainted with the skills and workmanship needed for ships.

In 1757, equipped with the education and experience provided by his parents and after a one-year apprenticeship, Watt moved to Glasgow where he was presented with the opportunity to work as a mathematical instrument's maker for a university. In 1764, Watt was presented with the opportunity to work on a Newcomen engine where he discovered many inefficiencies with the design. Such knowledge sparked a cascade of inventions aimed to improve the Newcomen engine. Most notably, his 1765 invention introducing a second condenser to the engine which improved the Newcomen engine by targeting the loss of latent heat. With the financial help of John Roebuck, Watt was able to make his own rendition of the steam engine and patent it in 1769 under "A New Invented Method of Lessening the Consumption of Steam and Fuel in Fire Engines."

Due to Roebuck's financial issue, Matthew Boulton took over a share in Watt's patent and in 1775, Boulton and Watt began their 25-year partnership. With Boulton's support, over the next 25 years, Watt was able to work on various inventions. These included; the sun-and-planet gear, double acting engines, parallel motion in an engine, and the pressure gauge among others.

The great amount of success in his inventions allowed Watt to develop an extensive fortune by 1790. Not only was Watt well off by the time he retired in 1800, in 1785, along with Boulton, he was elected as a fellow of the Royal Society of London. In addition, Watt married twice, once to his Cousin Margaret Miller whom he had six children with and died in 1773, and later to Anne McGrigor, whom he had two children with. Following his retirement, his son, James along with Boulton's son, Matthew, took over management of the firm Watt and Boulton created. Watt died in August 25, 1819. However, his legacy still lives on today and as a testament to his contributions to science and engineering, the unit of power in SI, Watt, was named after him.

References

[1] https://www.bbc.co.uk/history/historic_figures/watt_james.shtml
[2] https://www.britannica.com/biography/James-Watt/Later-years
[3] https://www.famousscientists.org/james-watt/

Edward Haug Biography

Born: September 15, 1940

Name: Abdullah Alsayegh

Professor: Dr. H.J. Sommer

Edward Haug

Edward J. Haug was a mechanical engineer who made significant contributions to kinematics and dynamics (Haug, 1989). He pioneered multibody systems dynamics and structural optimization (Haug, 2021a). Between 1968 and 1998, he was a Mechanical Engineering professor. He founded the Center for Computer-Aided Design and acted as the company's executive director between 1980 and 1995. This company specializes in mechanical system design virtual prototyping (Haug, 2021b). He also initiated the most sophisticated design for highway safety, known as National Advanced Driving Simulator, acting as the managing director between 1992 and 1998.

Throughout his career, he mentored many students pursuing PhD, transforming them into leaders in the universities and other fields within the industry. In collaboration with some graduates, Edward developed DADs, a computational program that enabled the government and the industry to enhance conditions for vehicular dynamics. The program later advanced into CADSI, Inc, becoming the first spin-off at Lowa University’s Research Park (Haug, 1989). Besides tutoring in universities, Edward authored, edited and published many books and articles whose impact is felt in kinematics and dynamics to date.

References:

Haug, E. J. (2021a). Multibody Dynamics on Differentiable Manifolds. *Journal of Computational and Nonlinear Dynamics*, *16*(4), 041003. Retrieved from: https://www.researchgate.net/publication/349574044_Edward_J_Haug_Multibody_Dynamics_on_Differentiable_Manifolds

Haug, E. J. (1989). *Computer-aided kinematics and dynamics of mechanical systems. Vol. 1: basic methods*. Allyn & Bacon, Inc. retrieved from: https://engineering.uiowa.edu/alumni-and-friends/awards-alumni-and-friends/honor-wall/legacy-iowa-engineering/edward-j-haug

Haug, E. J. (2021b). Computer-aided kinematics and dynamics of mechanical systems. Retrieved from: https://www.researchgate.net/publication/242634026_Computer-Aided_Kinematics_and_Dynamics_of_Mechanical_Systems_Volume-I

ROBERT FULTON

(November 14, 1765 – February 24, 1815)

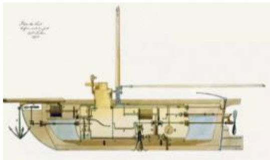
Robert Fulton, Ref: [4]

Robert Fulton was an American inventor, engineer and artist who is best known for design and operation of world's first commercially successful steamboat along with the design of a system of inland waterways, steam warship and the invention of Nautilus, one of the world's first practical submarine.

Fulton was born in Little Britain, Pennsylvania to Irish immigrant parents. His family moved to Lancaster in 1771. At the age of fifteen, he worked as an apprentice in a jewellery shop in Philadelphia where his skill at painting miniature portraits on ivory for lockets inspired Fulton to pursue career as an artist. In 1786, he moved to Bath, Virginia where his paintings were admired by people who advised him to study in Europe. Hence, in 1787, Fulton travelled to London but his success as a painter was only limited.

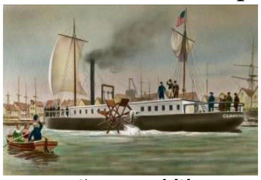
In 1794, Fulton directed his efforts towards canal engineering. In 1796, in his *Treatise on the Improvement of Canal Navigation*, he proposed a system of inland water transportation combining existing rivers with a network of manmade canals. It included details on inclined planes for hauling canal boats in difficult terrains, steamboats for carrying heavy cargo in shallow waters and bridge designs transmitting only vertical loads to the piers. He also invented a mechanical dredge to speed the construction of canals.

In 1797, Fulton travelled to Paris to propose the idea of building a submarine to the French government for use in the war against Britain. This submarine was supposed to place powder mines under the hulls of British warships. He finally built the *Nautilus* submarine in 1800 after permission from the Minister of Marine of France. The ship performed well during its trials, but wasn't fast enough to engage ships of the British navy.



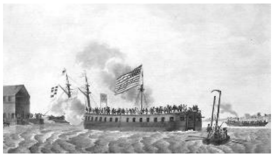
Nautilus, Ref: [1]

In 1801, Fulton partnered with Robert Livingston to build a 66-foot-long boat with 8 horsepower engine using Fulton's design. This was tested on River Seine in Paris in August, 1803. Although, the engine broke the hull, they were encouraged by the speed achieved against the current. After four years of development, in 1807, Fulton launched *Clermont*, steam powered vessel that made 150-mile journey up the Hudson River from New York City to Albany in 32 hours at a speed of 5 miles per hour, reducing usual sailing time by 64 hours. The Clermont used steam engine designed by James Watt. The Clermont with two other Fulton designed steamboats were commissioned for regular passenger and freight service on Hudson and Raritan rivers by 1810. With the partnership of Livingston and Nicholas Roosevelt, he also built The New Orleans Steamboat for journey from Pittsburgh to New Orleans.



Clermont, Ref: [2]

Fulton was also a member of the 1812 commission that recommended building the Erie Canal. He proposed the idea of building mobile floating gun platform to protect New York Harbour. Thus, the heavily gunned and armored steamship *Demologos* (alternatively known as Fulton) was launched in October 1814. It underwent successful sea trials but was never used in the battle.



Demologos, Ref: [1]

Fulton married Harriet Livingston in 1808. After 1812, Fulton spent most of his wealth on legal battles protecting his steamboat patents. He died at the age of 49 in New York due to pneumonia. He enabled affordable and dependable transportation of raw materials and finished good which proved essential in the American industrial revolution.

REFERENCES:

[1] Hartenberg, Richard S., "Robert Fulton". Encyclopedia Britannica, Nov. 10, 2021, https://www.britannica.com/biography/Robert-Fulton-American-inventor Accessed 24 January 2022

[2] Longley, Robert, "Biography of Robert Fulton, Inventor of the Steamboat." ThoughtCo, Dec. 6, 2021, thoughtco.com/robert-fulton-steamboat-4075444. Accessed 24 January 2022

[3] Tom Ricci, "Robert Fulton" ASME.org, May 14, 2012, https://www.asme.org/topics-resources/content/robert-fulton. Accessed 24 January 2022

[4] National Inventors Hall of Fame, "Robert Fulton - Steamboat" inducted in 2006, https://www.invent.org/inductees/robert-fulton. Accessed 24 January 2022

Alex Belchou

John Harrison
April 3rd 1693 – March 24th 1776

John Harrison was a British horologist known for inventing the first marine chronometer, a timepiece that can keep time on a moving ship with sufficient accuracy to compute the longitude of a ship at sea. Harrison was born on April 3rd, 1693 in Foulby, England. He was the eldest of five children in his family and his father was a carpenter. In his youth he learned woodworking from his father, a skill he would use for much of his life.

As a teenager he expressed a great interest in book learning. In 1712 a visiting clergyman lent Harrison a manuscript of a lecture series on natural philosophy which nurtured his interest in mechanics. In 1713 he combined his interest in mechanics with his practical knowledge of woodworking and made his first pendulum clock almost entirely out of wood that survives to this day. In 1715 and 1717 Harrison built two more wooden clocks of similar design.

By the early 1720s, Harrison had gained a reputation has a clockmaker and was hired by Sir Charles Pelham to build a tower clock at his manor house. The tower clock, completed in 1722, has run nearly continuously for over 270 years, a testament to Harrison's skill as a clockmaker.

From 1725 to 1727, Harrison, with the help of his brother James, built two grandfather clocks. These clocks were the first to incorporate Harrison's new inventions: the gridiron which compensates for thermal expansion and keeps the pendulum at a fixed length, and the grasshopper escapement that counts the pendulum swings with minimal friction. It was also in the year 1727 that Harrison decided to tackle the longitude problem and build the world's first marine chronometer.

In 1730 Harrison began work on his first attempt at a marine chronometer. After five years of work, he completed the H-1. The H-1 was constructed from brass with wooden gears and weight in at 75 pounds. The H-1 went on its sea trial to Lisbon in 1736 under Captain Proctor of the Centurion. On its return voyage to London in 1737, the H-1 was able to correct an error in navigation which greatly impressed the captain. Despite having proved the efficacy of the H-1, Harrison chose not to accept the Longitude prize and rather accept a stipend to work for two more years and improve his design.

In 1741 Harrison presented his improved chronometer, the H-2, to the Board of Longitude. The improved H-2 weight in at 86 pounds and featured a more uniform drive and better temperature compensation. As with the H-1, Harrison asked again for a chance to further improve his design. His request was granted, and the H-2 never went to sea. The Board however, was very impressed with the results of the tests conducted on land.

Harrison spent the next 19 years working on the H-3. This iteration of the chronometer was the first to feature caged ball bearings, a substantial advancement. It also did away with the gridiron in favor of a bimetallic strip for temperature compensation. It was also the smallest and lightest chronometer yet at 60 pounds. Having finished the H-3 in 1757 Harrison was dissatisfied with its performance and it too never went to sea.

Inspired by a precision watch gifted to him, Harrison switched from a clock design to a watch design for his final chronometer, H-4. The H-4 being a watch formfactor did away with many of the bulky mechanisms from the previous chronometers. The compact bimetallic strip was kept for temperature compensation, but the ball bearings were replaced with diamond plain bearings. Completed in 1759, the five-inch, 3-pound H-4 was the chronometer that eventually won Harrison the Longitude Prize after much struggle and argument with the Board.

Alex Belchou

Works Cited:

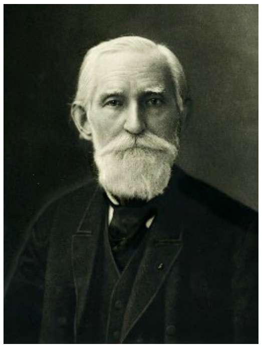
Sobel, Dava (1995). Longitude: The True Story of a Lone Genius Who Solved the Greatest Scientific Problem of His Time. New York: Penguin. ISBN 0-14-025879-5.

https://en.wikipedia.org/wiki/John_Harrison

https://www.britannica.com/biography/John-Harrison-British-horologist

Pafnuty Chebyshev (1821-1894)

Christian Bergen



Pafnuty Lvovich Chebyshev was a Russian mathematician and mathematics professor at St. Petersburg University with contributions to probability theory, quadratic forms, number theory and kinematics [1]. He is considered the father of modern kinematics in Russia for his numerous contributions in the field.

Chebyshev was born in Okatovo, a town near Moscow, to an upper-class family with eight other siblings. In his early education, he was taught French which was invaluable to his future connections with French mathematicians. His family moved to Moscow when he was 11 years old, where he received top-notch tutoring in math by published elementary mathematics tutor P N Pogorelski before starting higher education [2].

Chebyshev attended Moscow University, where he was most influenced by mathematics professor and advisor Nikolai Dmetrievich Brashman towards mechanical engineering and statistics. As an undergraduate, he was recognized for his paper *The Calculation of Roots of Equations* where he solved general cases for $y = f(x)$ using series expansions for $f^{-1}(x)$ [2].

Chebyshev became fascinated with the theory of mechanisms after traveling to France, Germany, and London to study the mechanics of steam engines and meet several European mathematicians. Following this trip, he made one of his greatest contributions to math with the generalization of orthogonal polynomials, with applications in interpolation and quadrature. Previously only specific cases such as Legendre polynomials were studied [2].

One of his most influential contributions to mathematics was Chebyshev's inequality [3], which proved that a certain percentage of values around the mean were contained within a standard deviation for many probability distributions. It says that only $1/k^2$ of a distribution's values are contained within k standard deviations from the mean. It is useful because it can be applied to any dataset given its mean and variance.

As the name suggests, Chebyshev invented the Chebyshev linkage [4], a four-bar linkage that can very closely approximate a straight line for a limited range of motion. The straight line is traced at the center of fully revolute link L_3 in a double-rocker when the ratio of lengths of the links $L_1, L_2, and\ L_3$ are $4:5:2$ and $L_2 = L_4$. The input angle limits on L_2 where the line traced remains straight is between about 36.9° and 101.5°. Linkages that contained a straight-line motion were of potential usage in steam engines at the time.

References:

[1] R. Hartenberg and J. Danavit, *Kinematic Synthesis of Linkages*. New York: McGraw-Hill, 1964. Accessed: Jan. 24, 2022. [Online]. Available: https://ecommons.cornell.edu/handle/1813/58640

[2] “Pafnuty Chebyshev - Biography,” *Maths History*. https://mathshistory.st-andrews.ac.uk/Biographies/Chebyshev/ (accessed Jan. 26, 2022).

[3] “Chebyshev’s inequality,” *Wikipedia*. Dec. 25, 2021. Accessed: Jan. 26, 2022. [Online]. Available: https://en.wikipedia.org/w/index.php?title=Chebyshev%27s_inequality&oldid=1062028766

[4] “Chebyshev linkage,” *Wikipedia*. Apr. 09, 2021. Accessed: Jan. 26, 2022. [Online]. Available: https://en.wikipedia.org/w/index.php?title=Chebyshev_linkage&oldid=1016938246

Dan Negrut

Date of Birth: Unknown

Samuel Cowan

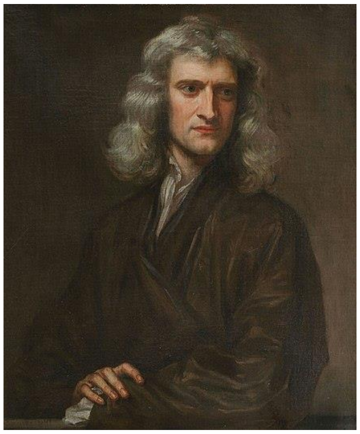
Dan Negrut was born in Communist Romania [1][2]. He received his BS in aeronautics from Polytechnic Institute of Bucharest in Romania in 1992. In 1998, Dan received his PhD in mechanical engineering from the University of Iowa. His thesis was on creating more efficient algorithms for multibody dynamics using numerical methods [3]. His interest in computational dynamics led to a career of using numerical methods to model complex, multibody dynamics.

Today, Dan is a professor at the University of Wisconsin – Madison. His research interests are computational dynamics, high performance computing, and autonomous vehicle simulation. He has published dozens of works on these topics [2]. His work in this field resulted in a leadership position at the Simulation Based Engineering Lab (SBEL). The SBEL develops models and software solutions to accurately predict mechanical systems with respect to time [2].

His work at the SBEL has involved using supercomputers to model multibody and many-body dynamic problems. One simulation modeled the interaction between an autonomous vehicle and sand. The individual grains of sand were modeled by using the many-body dynamic approach which accounted for the deformation and friction forces of the sand [2][4]. This approach has a high computational cost due to all the bodies involved. However, it allows for more accurate predictions of how a vehicle will react to different terrains and obstacles. Dan used a similar approach to model fluid dynamic problems by modeling a fluid as millions of bodies, then solving it using multibody techniques [2]. Dan's research has led to more efficient numerical methods to solve complex, multibody dynamic problems. Also, his work has reduced the computational powered required to solve these types of problems. Due to his work, Dan was awarded the NVIDIA CUDA Fellow award [4].

1. COFES (2016, March 24). "Multi Body Dynamics to Many Body Dynamics – Dan Negrut". *Youtube.* https://www.youtube.com/watch?v=x34bROWqPeE
2. Simulation Based Engineering Lab (SBEL) (2021). Dan Negrut. *University of Wisconsin – Madison. https://sbel.wisc.edu/negrut-dan/*
3. Negrut, D. (1998, July). "On the Implicit Integration of Differential-Algebraic Equations of Multibody Dynamics". *The University of Iowa*. https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.674.3720&rep=rep1&type=pdf
4. Dan Negrut (2021), *College of Engineering, University of Wisconsin – Madison. https://directory.engr.wisc.edu/me/Faculty/Negrut_Dan/*
5. eScience Institute Guest Seminar: Dan Negrut (2019). *University of Washington*. https://escience.washington.edu/events/guest-seminar-dan-negrut/

Sir Isaac Newton's Life on One Page (December 25, 1642 - March 20, 1727)



Isaac Newton's life and contributions to various aspects modern physics are unique and arguably unparalleled. His childhood education in England was one of underperformance. This stood in sharp contrast to the potential he exhibited though an understanding of mechanical concepts and skills in designing and building small windmills and clocks as a child. This potential would unleash itself throughout his later life when the once-labelled inattentive and mediocre student would go on to revolutionize physics as we know it. Newton's unique ability to methodically work through scientific questions, subsequently answering these, moving forward with more questions, and reflecting on the answers, seems to have been a key to his success.

Newton's education took a turn at around age 10 when he began displaying intellectual potential and curiosity. He went on to Trinity College at Cambridge University, where he was elected scholar. While at home in Lincolnshire during a break from his studies due to the the bubonic plague of 1665, he focused on mechanics, mathematics and began study of optics and gravitation. He referred to this prolific time as his "miraculous year," during which he pondered gravitation and conducted his gravitational pendulum experiments. Newton returned to Cambridge to study the writings of Thomas Hobbes and Robert Boyle but was especially interested in the works of Copernicus, Galileo and Kepler on mechanics, astronomy, and optics, respectively. He was appointed Lucasian Professor in 1669 with a focus on optics. He would go on to perform various experiments showing that white light is composed of all the colors of the spectrum and behaved as small particles, a contrarian concept which drew his contemporaries' criticism, and ultimately postponed the publishing proof in his later book, *Opticks*.

Newton spent much of his life withholding his work from publication due to feuds with his contemporaries. He discovered calculus while solving problems related to curvature around 1666 but did not publish, leading to arguments over priority when German mathematician Gottfried Leibniz published his own similar works many years later. Newton built upon the work of Johannes Kepler, describing orbiting bodies around the sun. Newton synthesized his inverse-square gravitational law by applying his own law of centrifugal force to Kepler's laws of planetary motion. Using data from Galileo, Newton tested his theory and later went on to prove the elliptical orbits of celestial bodies. His refined works and proofs made up a part of this 3-book masterpiece *Principia*, which included Newton's 3 laws of motion, a rigorous mathematical study on fluid mechanics, and finally universal gravitation. This final book explained the motion of the moon, the tides, and elliptical planetary orbits.

Newton discovered calculous, pioneered modern mechanics, and greatly advanced scientific knowledge of both planetary motion and optics. He built on the works of Kepler, Copernicus, Galileo, and others to create a new mathematical understanding of gravitation and planetary motion. He ultimately published these works, including *Principia*, the first book on theoretical physics and the basis for our modern understanding of physics to this day.

References:

Hawking, S., 2002. *On the shoulders of giants: The great works of physics and astronomy*.

Brewster, D., 1875. *The Life of Sir Isaac Newton*. W. Legg & Company.

Keynes, J.M., 2010. Newton, the man. In *Essays in biography* (pp. 363-374). Palgrave Macmillan, London.

Iliffe, R. and Smith, G.E. eds., 2016. *The Cambridge Companion to Newton*. Cambridge University Press.

Portrait of Newton at 46 by Godfrey Kneller, 1689

A Brief Biography of Thomas Newcomen, Kinematician (February 1664 – August 5, 1729)
By Michael Forstmeier

Thomas Newcomen
(famousscientist.org)

Thomas Newcomen was born in February 1664 – the exact date unknown – in Dartmouth, England. He was the son of a shipowner and worked as an ironmonger for many years. An engineer by apprenticeship, Newcomen was trained in the hard sciences. He solidified himself as a kinematician worth his weight in gold by helping develop the precursor to modern piston-cylinder engines. The legacy of his work affects our lives today [1].

During the years in which he worked as an ironmonger, and through his close ties with the local tin miners, Newcomen learned about the inefficiencies of contemporary water extraction methods. At the time, the methods were slow and costly, requiring horses to draw the water out [2]. Recognizing the need for technological innovation, Newcomen began working on a pump of his own design.

Working with a plumber by the name of John Calley, Newcomen eventually developed what is now considered the precursor to the Watt steam engine. Although Newcomen's pump was innovative and effective, he was unable to file a patent; just a few years prior, in 1698, an inventor by the name of Thomas Savery invented and patented a similar, albeit less efficient, pump. Because the patent Savery obtained was broad, Newcomen had little chance of securing a separate patent. And instead of waiting until Savery's patent ran out, Newcomen entered a formal partnership with him and in 1712 the first Newcomen engine was manufactured [1,2].

The pump, though crude, enabled miners to extract water from their mines 24 hours a day; further, the pump was used to raise water levels for water wheels [1]. Newcomen's pump used atmospheric pressure, steam, and rapid cooling in such a way to extract water. Specifically, steam powered the in-stroke by pushing the piston upward in the cylinder. Upon completion of the in-stroke, the steamed cylinder was rapid cooled; this caused a negative pressure to develop in the chamber and produced downward movement in what is known as the out-stroke [3]. This two-part stroke cycle was timed and repeated. Still, at least by modern standards, the pump was slow and large. According to famousscientist.org, "The brass cylinder was 21 inches in diameter and 7 feet 10 inches high, and the engine made twelve strokes per minute, each stroke lifting 10 gallons (45 liters) through 51 yards (46 meters) perpendicularly." This equates to 120 gallons per minute (GPM), which was excellent for the era in which it was created.

He worked on his engine until he past away at the age of 65 in 1729. By 1733, after his patent had expired, there were over 100 Newcomen engines in the world (mostly in the United Kingdom). Today, there is a life-size model of his original design in a Birmingham, UK museum [2].

References

[1] *Thomas Newcomen,* taken from: https://www.famousscientists.org/thomas-newcomen/ on Jan 19, 2022.

[2] *Thomas Newcomen: British Engineer and Inventor,* taken from: https://www.britannica.com/biography/Thomas-Newcomen on Jan. 18, 2022.

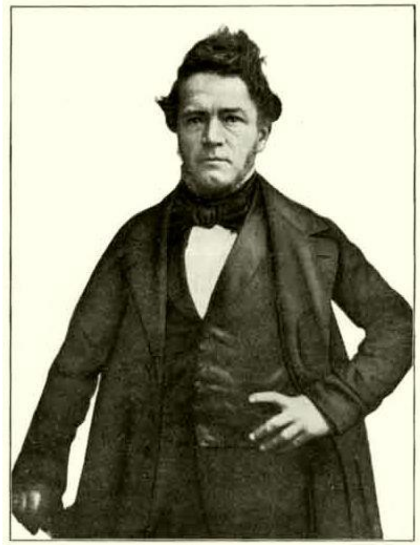
[3] *Newcomen atmospheric engine,* taken from: https://www.nms.ac.uk/explore-our-collections/stories/science-and-technology/newcomen-engine/ on Jan 24, 2022.

ME 581 – H02 **Samson Galvin**

Ferdinand Jakob Redtenbacher

Born: July 25, 1809

Died: April 16, 1863



Ferdinand Redtenbacher was born in Steyr, Austria during a transition period into the industrial age. His father was an ironmonger and prosperous merchant who apprenticed his son. After years of working for his father and self-educating himself, Ferdinand decided to pursue a formal education and decided to become an engineer in 1825. He attended Polytechnikum in Vienna from 1825 to 1829 where he would stay until moving to Zurich to become a professor. Ferdinand taught mathematics and geometry at the Höhere Industrieschule in Zurich for several years and became a professor in mechanics and mechanical engineering in 1841 at the Polytechnikum Karlsruhe.

Before his time, mechanical engineering was a "workshop-based" profession and relied very little on mathematics. When Ferdinand became a professor in mechanics and mechanical engineering at the Polytechnikum Karlsruhe, he transformed the school into the international standard for mechanical engineering. This standard is greatly responsible for the success of German engineering in the following century. Ferdinand studied many mathematicians, such as Euler, Poisson, and Laplace, but found the theoretical equations were difficult to apply in practice. He created specialized books on engines to make it easier to apply theoretical formulas. Ferdinand Redtenbacher taught with both empirical English style and his own theoretical style. This teaching method is now taught in all mechanical engineering classes and is why he is the founder of science-based mechanical engineering.

Redtenbacher has influenced a lot of engineering over the last two centuries, but he is also known for his construction of kinematic models for teaching. There is a model collection of mechanisms at the University of Karlsruhe made by Redtenbacher.

His students became famous engineers as well. Eugen Langen helped create the internal combustion engine. And Franz Reuleaux helped establish modern principles of kinematics of machines. He was an important historical figure who not only re-established how mechanical engineering is taught but was a crucial node in helping his students create important discoveries.

References:

[1] Wauer, J., et al. “Ferdinand Redtenbacher (1809–1863): Pioneer in Scientific Machine Engineering.” *Mechanism and Machine Theory*, Pergamon, 9 June 2009, https://www.sciencedirect.com/science/article/abs/pii/S0094114X09000925.

[2] “." Complete Dictionary of Scientific Biography. . Encyclopedia.com. 29 Dec. 2021 .” *Encyclopedia.com*, Encyclopedia.com, 25 Jan. 2022, https://www.encyclopedia.com/science/dictionaries-thesauruses-pictures-and-press-releases/redtenbacher-ferdinand-jakob.

[3] *Ferdinand Redtenbacher (1809–1863): Pioneer in Scientific ...* https://www.researchgate.net/publication/223766269_Ferdinand_Redtenbacher_1809-1863_Pioneer_in_scientific_machine_engineering.

[4] “Ferdinand Redtenbacher.” *Wikipedia*, Wikimedia Foundation, 24 July 2020, https://en.wikipedia.org/wiki/Ferdinand_Redtenbacher.

Biography of Joseph- Louis Lagrange (January 25, 1736 – April 10, 1813)

By: Raymond Girroir

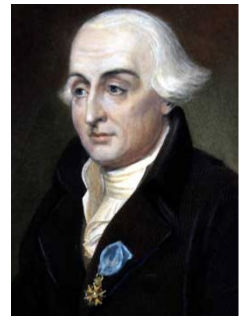


Image obtained from Wikipedia

According to O'Conner and Robertson's article *"Joseph-Louis Lagrange*," Joseph- Louis Lagrange was born in Turin, Italy, formally known as Sardinia-Piedmont. Joseph Lagrange's father was the king of Sardinia's treasurer but financially struggled due to his losses in financial speculation. His father had chosen a law path for Joseph that would bring him to study at the University of Turin (1999). Lagrange, at first, did not have a likening for mathematics, and it was not until he picked up a memoir written by Edmond Halley, an English astronomer (Struik, n.d.). This memoir, which was the use of algebra in optics, coupled with an attraction to physics sparked at college, was the tipping point for Joseph to pursue a career in mathematics (O'Conner, Robertson, 1999). Joseph started on the journey of self-taught mathematics at 16 and was appointed a professorship at the Royal Artillery School in Turin by the age of 19 (Seikali, n.d.). Early in Lagrange's career, Lenord Euler recognized his work regarding the propagation of sound and his concept of maxima and minima in the calculus of variations (Struik, n.d.). Joseph Lagrange used the calculus variations to expound upon virtual work and how it can be applied to all static and dynamic mechanisms. Lagrange also developed the word derivative and the notation we use today, f' (x) (Joseph, n.d.). According to the Famous Scientist website, Joseph Lagrange was offered a prestigious position from Euler and was duly elected to be a foreign member of the Berlin Academy at age 20. It was not until he turned 30 that he would move to Berlin to replace Euler as the director of mathematics at the Prussian Academy of Science (n.d.). Lagrange would contribute to mathematics significantly during his time in Berlin, including Partial Differential Equations, Group Theory and Symmetry, Lagrangian Points, and Lagrangian Mechanics. Lagrange was rather proud that his book on mechanics was rooted in the single fundamentals of virtual work and did not contain any figures, stating that algebra and calculus coupled with analysis were more important than intuitive thinking derived from diagrams. (Joseph, n.d.). Another large contribution came when the revolution began in 1789 while living in Paris, where Lagrange would help reform the metric system (Struik, n.d.). Joseph-Louis Lagrange died at the age of 77, survived by his wife Renee. He was buried at the Pantheon, and his name was engraved on the Eiffel Tower when it opened in 1889 (Joseph, n.d.).

References

Joseph-Lewis Lagrange. Famous Scientists. (n.d.). Retrieved January 24, 2022, from https://www.famousscientists.org/joseph-louis-lagrange/

O'Connor, J. J., & Robertson, E. F. (January, 1999). Joseph-Louis Lagrange - Biography. Maths History. Retrieved January 24, 2022, from https://mathshistory.st-andrews.ac.uk/Biographies/Lagrange/

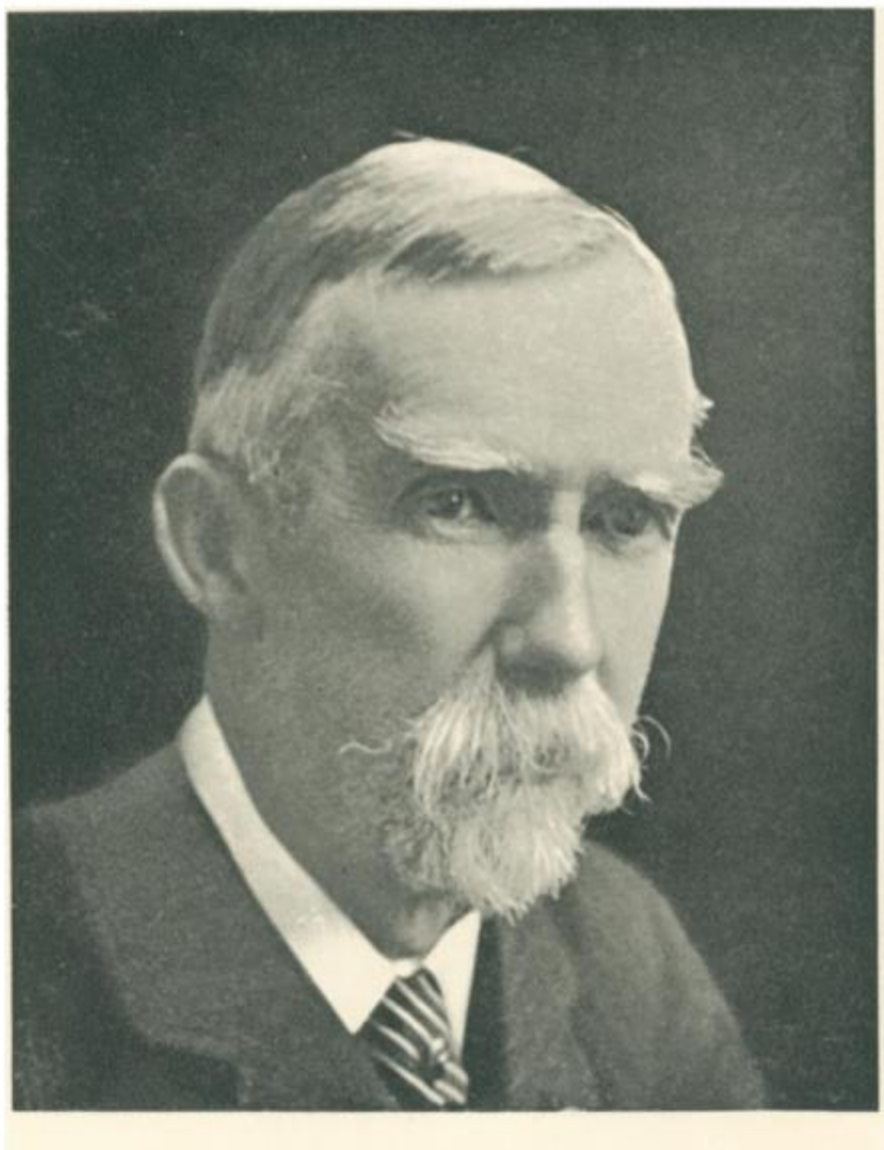
Seikali, S. (n.d.). *Joseph-Lewis Langrange* . Joseph-Louis Lagrange. Retrieved January 24, 2022, from https://math.berkeley.edu/~robin/Lagrange/

Struik, D. J. (n.d.). *Joseph-Louis Lagrange, Comte de l'Empire*. Encyclopædia Britannica. Retrieved January 24, 2022, from https://www.britannica.com/biography/Joseph-Louis-Lagrange-comte-de-lEmpire

Alexander Kennedy

17 March 1847 – 1 November 1928

Biography by Steve Harnett for ME 581, Spring 2022



Citations

[1] Gibb, A. (1938). Sir Alexander Blackie William Kennedy. 1847-1928. Obituary Notices of Fellows of the Royal Society, 2(6), 213–223. http://www.jstor.org/stable/769056

[2] Reuleaux, F, Kennedy, A. (1876). *The Kinematics of Machinery*. https://archive.org/details/kinematicsofmach00reulrich/page/n5/mode/2up?view=theater

[3] Moore, A, Kennedy, A. (1902). *The Alps in 1864, A Private Journal*. https://archive.org/details/alpsinaprivatej00kenngoog/page/n10/mode/2up?view=theater

Sir Alexander Kennedy was a British engineer, mountaineer, and photographer from Stepney, London. He had a family history of oration and academia, being born to a reverend and the sister of a professor of Greek at Edinburgh University. As an engineer, he was skilled in a number of engineering disciplines, receiving his initial schooling in marine and mechanical engineering but then going on to perform research in civil engineering and electrical engineering. Outside of his engineering career he left a mark on several fields including archaeology, photography, and, perhaps most notably, mountaineering as a member of the Alpine Club.

As was traditional at the time of his schooling, Kennedy left school at the age of seventeen to apprentice in industry and gain applied experience. He worked as a draughtsman for shipyards and engine designers, gaining experience in marine engineering and mechanical engineering. This fusion of classroom and industry experience influenced Kennedy's instructional style when he returned to academia. At the age of twenty-seven he was appointed to a professorship at University College, London in Mechanical Engineering, where he challenged the status quo of practical-focused education by bringing in an emphasis on teaching from first principles and theory, such as his insistence on teaching thermodynamics along with boiler design and solid mechanics along with structure design. In 1878, development of an engineering laboratory was started at University College, London on Kennedy's suggestion that hands-on learning was a necessary compliment to in-classroom theoretical teaching. The laboratory would be worked in by students rather than by instructing professors, a novel concept at the time.

Kennedy's contributions to academic instruction go far beyond University College, London; in 1876 he translated Franz Reuleaux's "Kinematics of Machinery," thereby bringing Reuleaux's component mechanism-focused approach to design and analysis of machinery to English-speaking audiences around the world. Kennedy employed his own hands-on approach to learning during his translation work when Reauleaux sent Kennedy over three-hundred models[1] to study in-person while translating the text. Kennedy's work outside of mechanical engineering includes contributions to civil and electrical engineering. He used his newly built lab at University College, London to conduct numerous experiments on the elasticity of materials and the strength of riveted joints, which earned him a spot as a Fellow in the Royal Society in 1887. He contributed to electrical engineering by studying the use of steam and gas generators for electric lighting, publishing his results in 1889. After retiring from his professorship, he would go on to consult in these fields, advising the design of numerous buildings, structures, power plants, and electrical railways.

Outside of his engineering work, Kennedy's mountaineering interest and photography hobby are notable for the publications they produced. In 1902, he published an updated edition of Moore's "The Alps" adding his own photographs of the mountain range. In 1925 he published "Petra: its History and Monuments" bringing his photographs of the ruins at Petra to a Western audience that had largely been unable to see the site in recent years due to the Ottoman Empire's presence there. Kennedy's knighthood was conferred in 1905 for his diverse contributions to crown and country. He passed in his home in London in 1928.

1 Biographer's note: Many of Reuleaux's models were also gifted to Ezra Cornell and are housed on Cornell's Ithaca campus to this day, where they are still turned into CAD models every fall by sophomore mechanical engineering students as part of the students' introductory design course.

Cameron Hoover – ME 581

René Descartes

31 March 1596 – 11 February 1650

Rene Descartes was a French mathematician, scientist, and philosopher. Descartes formulated the mind-body dualism and promoted new science which later became known as Cartesianism, which was based on observation and experiment. This led to Descartes being known as the "founder of modern philosophy". Descartes made many contributions to the mathematical field specifically around the development of Cartesian geometry. Descartes' work is currently regarded as having a large influence on many of Isaac Newton's contributions in the field of mathematics, including Newton's laws of motion. [4]

Descartes was born in Touraine France in 1596. In 1607 Descartes began attending College Royal Henry-Le-Grand, a French military school. During this time, he was introduced to physics and mathematics including some of Galileo's work. He would later go on to earn a Baccalaureate and License in canon and civil law in 1616 from the University of Poitiers. Descartes then moved to Breda where he studied mathematics, physics, and military architecture while in the peacetime army of Prince Maurice. During this time, specifically in 1619, Descartes would develop Cartesian geometry and a universal method of deductive reasoning, which was later formulated in *Discourse on Method*. In addition to mathematical developments, Descartes also studies physics where he formulated many theories on mechanical and geometric physics such as an early form of conservation of momentum and his laws of motion, which went on to influence Newton's laws of motion. [1][4]

Descartes' most important development, Cartesian geometry made possible the conversion of geometry into algebra, and algebra into geometry. Cartesian geometry allowed for the creation of Calculus by Newton and Leibniz, as well as the ability to navigate geometries of higher dimensions and the ability to graphically solve simultaneous equations. The development of Cartesian geometry was a foundational tool that transformed mathematics. [1]

In addition to Descartes' mathematical accomplishments, he also wrote one of the most influential books on modern philosophy, *Discourse on Method*. Skepticism is one of the main topics discussed in the paper as it had been previously discussed by philosophers. Descartes' took a slightly modified approach which led to an important rule which defined modern philosophy "never to accept anything for true which I did not clearly know to be such." This modified approach to skepticism also led to the famous "first principle" of Descartes' philosophy "I doubt, therefore I think, therefore I am". Descartes' contributions in *Discourse on Method* became the foundation of modern philosophy and garnered the title of founder of modern philosophy. [2]

Descartes went on to continue his work with philosophy, mathematics, and physics, while also delving into theology in his later years, due to the suppression of information by the Catholic church. Descartes would later contract pneumonia at the age of 53 while teaching Queen Christina about philosophy. [3]

References:

[1] Domski, Mary. “Descartes' Mathematics.” *Stanford Encyclopedia of Philosophy*, Stanford University, 28 Apr. 2021, https://plato.stanford.edu/entries/descartes-mathematics/.

[2] Hatfield, Gary. “René Descartes.” *Stanford Encyclopedia of Philosophy*, Stanford University, 16 Jan. 2014, https://plato.stanford.edu/entries/descartes/.

[3] “René Descartes.” *Biography.com*, A&E Networks Television, 27 May 2021, https://www.biography.com/scholar/rene-descartes.

[4] Watson, Richard. “René Descartes.” *Encyclopædia Britannica*, Encyclopædia Britannica, Inc., https://www.britannica.com/biography/Rene-Descartes.

Eli Whitney

December 8th, 1765 – January 8th, 1825

"The Father of American Technology"

Eli Whitney is widely considered to be a revolutionary in the manufacturing industry and a legendary inventor. Known as the "Father of American Technology", Whitney was born in Westborough, Massachusetts in 1765 as the son of a well-respected farmer [1, 2]. Whitney had an interest in mechanisms from a young age, constructing a violin at the age of 12 and acting ill so that he could stay home and deconstruct and rebuild his father's wristwatch [1]. At the age of 23, Whitney began college at Yale and graduated with the class of 1792. Following his graduation, Whitney had arrangements to be a private tutor for a family in Georgia. However, these plans were not seen through and Whitney was then hired as a farmer's mechanic to the widowed Mrs. Greene [1,3]. While at Greene's, a party of officers that had been under the command of Greene's diseased husband visited, mentioning the prosperity that would come with more effective cotton harvesting [1]. The major difficulty with this harvest was the task of removing the cotton fibers from the seeds efficiently. Within a few days Whitney had gone to find some cotton and within a few weeks assembled his prototype of the cotton engine, or "Cotton Gin".

The first iteration of this design involved wire hooks that would capture the cotton fibers in the periphery of a revolving wooden disk. As the fibers were pulled, they were then collected by a revolving brush while the cotton seeds passed through a narrow slot into a hopper. Only a year after graduating, he signed a contract with a Mr. Miller that would split the interest of the invention in half with Miller in exchange for the funds to proceed with patenting the design [1]. Obtaining the rights to the design, however, did not come easy. The simplicity in the design, along with the theft of the original Cotton Gin enabled many to be reproduced independent of Whitney and Miller [1]. By 1798, they had lost all lawsuits regarding suing those copying their design. In the first few years of the new century, Whitney was said to be nearing a nervous breakdown [1]. Some speculated that this could have been a result of anxiety due to a frustrated love for Mrs. Greene. Other evidence, including those from letters, show that this anxiety was caused by his longing for financial stability and a position of prestige [1].

After some struggles in obtaining patents, Whitney managed to obtain a deal with the U.S federal government to produce 10,000 muskets. His factory would be the first to produce interchangeable parts, allowing the parts of one musket to be used for another [4]. He did not reach his goal until nearly 10 years after his initially proposed date and although he is arguably the first to manufacture utilizing interchangeable parts, there were some issues due to the lack of standard measurement and drawing practices amongst all of the production plants [4].

Whitney's work on the Cotton Gin helped to establish the cotton industry. Although he thought his invention would limit the number of workers required, there was a greater demand for hands to harvest, and this lead to the expansion of the slave system [2-3]. In the late nineteenth century, many southern writers asserted that Whitney did not develop the Cotton Gin on his own, but received contributions from artisans in the south [3]. Some have suggested that Mrs. Greene, who was known for her mechanical ingenuity was behind the development or at least played a role [5]. Regardless, Whitney went on to make a respectable income from the U.S federal government in the production of arms and through his patents that were later obtained in some states. He died in 1825, leaving behind his wife Henrietta Edwards and seven Children. While some still search for the *"true"* inventor of the cotton gin, Whitney's tombstone reads "The Inventor of the Cotton Gin".

<u>References</u>

[1] Whitney, E., 1864, "THE MOST IMPORTANT AMERICAN DISCOVERIES AND INVENTIONS. No. 2. THE COTTON GIN. Whitney.—1792," Scientific American, **10**(10), pp. 146–147.

[2] *Eli Whitney: Father of American Technology - Fast Facts | History*.

[3] 1897, "Correspondence of Eli Whitney Relative to the Invention of the Cotton Gin," The American Historical Review, **3**(1), pp. 90–127.

[4] Woodbury, R. S., 1960, "The Legend of Eli Whitney and Interchangeable Parts," Technology and Culture, **1**(3), pp. 235–253.

[5] "Mothers of Invention Science: Recognition Has - ProQuest" [Online]. Available: https://www.proquest.com/docview/281690324?accountid=13158&parentSessionId=NLtcCcAQwVFvPAwT89SDasBIJHjdFHvmVdXFH%2B6lTZ8%3D&forcedol=true.

Franz Grashof

Born July 11, 1826

Death October 26, 1893

Alexander Mathews

Franz Grashof was born in the city of Dusseldorf in 1826 following the nation of Berg's unification with the Grand Duchy of the Lower Rhine [1]. At the age of 18 in the year 1844, Grashof proceeded to attend Gewerbe-Institut which is now known as Berlin Royal Technical Institute [1,2]. At this university he studied a multitude of subjects including mathematics, metallurgy, physics and machine design [2]. After studying for three years, he joined the military with a goal to become a marine officer [2]. However, this goal changed following a year of service where he proceeded to sail around the world visiting various locations such as Australia and the Dutch Indies [1]. It is noted that he taught at a technical school during is voyage which led him to study in Berlin until he completed his studies in 1854 [2]. Following his studies, he became a teacher of mechanics and mathematics for Berlin Royal Technical Institute [2]. In the year 1856, the Verein Deutscher Ingenieure (VDI) was formed by twenty-three engineers including Grashof whom was to include German engineers across the German states [2]. At this point in history the Germany nation was not unified and Holy Roman Empire dissolved fifty years prior as such the engineer members were comprised of German people from the twenty-five German states existing at the time. His reputation proceeded him as he assumed the role of director of the VDI and author of their publications which was known as the Zeitschrift [1,2]. One of such publications was the Theoretische Maschinenlehre which focused on various theories regarding mechanical theory of heat, hydraulics and much more [4]. In the year 1863, Grashof assumed the role of professor for applied mechanics at Karlsruhe University of Applied Sciences where he taught strength of materials, hydraulics, thermodynamics and machine design [2]. Achievement wise he is responsible for development of early steam-flow equations which is widely used in heat transfer convection [2]. Many years following his death a dimensionless number was named after him called the Grashof Number [2]. This number is utilized in heat transfer convection to identify laminar versus turbulent flow in a system [5]. The calculation for this number gives a relationship for buoyant force and viscous force where the greater Grashof number the weaker viscous force is in comparison to buoyant force [5]. Another achievement by Grashof was the creation of the Grashof criterion. This term is utilized in kinematics to determine if a four-bar chain is able to rotate 360 degrees [2]. Where for one link to make a full 360 degrees rotation the sum of the shortest and largest links is less than the sum of the other two links [3]. Grashof suffered his first stroke in 1882 where he was able to make a successful recovery and continue his work [3]. Unfortunately, in the year 1891 Grashof suffered a second stroke which limited his ability to contribute to the engineering society until his death in 1893 two years afterwards [2].

Citations

[1] Straub, Johannes, 2011, “Grashof Franz 1826-1893.” February 2, 2011, accessed January 24, 2022, https://thermopedia.com/content/823/.

[2] Prabook, “Franz Grashof.” Accessed January 24, 2022, https://prabook.com/web/franz.grashof/2445687.

[3] Memim, “Franz Grashof.” Accessed January 24, 2022, https://memim.com/franz-grashof.html.

[4] Nature, “Theoretische Maschinenlehre,” Nature, https://doi.org/10.1038/007045b0 https://www.nature.com/articles/007045b0

[5] ScienceDirect, “Grashof Number - an overview | ScienceDirect Topics,” accessed January 24, 2022, https://www.sciencedirect.com/topics/chemistry/grashof-number.

ME 581 – H02 **Name ____Lingsheng Meng___________________**

A biography of William Hamilton

8/4/1805 – 9/2/1865

William Rowan Hamilton

The reason I want to write this one page biography for William Hamilton is that I learned a course named Structral Dynamics and Vibrations last semester. The Hamilton's Principle was used throughout the whole semester. I felt how powerful and useful of the Hamilton's Principle in dynamics. So let's look at this great dynamicist.

Sir William Rowan Hamilton(4 August 1805 – 2 September 1865)[1] was an Irish mathematician, Andrews Professor of Astronomy at Trinity College Dublin, and Royal Astronomer of Ireland at Dunsink Observatory. He made major contributions to optics, classical mechanics and abstract algebra. His work was of importance to theoretical physics, particularly his reformulation of Newtonian mechanics, now called Hamiltonian mechanics. It is now central both to electromagnetism and to quantum mechanics. In pure mathematics, he is best known as the inventor of quaternions [2].

Hamilton is said to have shown immense talent at a very early age. He was not only good at mathematics but also displayed an uncanny ability to acquire languages. When he was thirteen years old, he was in different degrees acquainted with thirteen languages, besides the vernacular - Syriac, Persian, Arabic, Sanscrit, Hindoostanee, Malay, French, Italian, Spanish and German. In September 1813, the American calculating prodigy Zerah Colburn was being exhibited in Dublin. 8-year-old Hamilton was defeated by a boy who is a year older in a mental arithmetic contest. After that, Hamilton dedicated less time to studying languages and more time to studying mathematics [3].

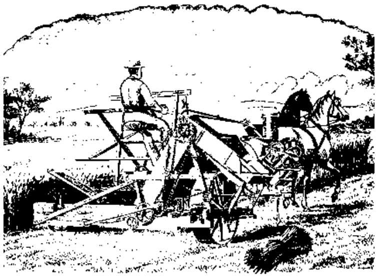
Despite the importance of his contributions to algebra and to optics, posterity accords him greatest fame for his dynamics. The formulation that he devised for classical mechanics proved to be equally suited to quantum theory, whose development it facilitated. The Hamiltonian formalism shows no signs of obsolescence; new ideas continue to find this the most natural medium for their description and development, and the function that is now universally known as the Hamiltonian, is the starting-point for calculation in almost any area of physics. [4]

However, his personal life was not going so smoothly as his research life. While attending Trinity College, Hamilton proposed to his friend's sister, who rejected him. Hamilton, being a sensitive young man, became sick and depressed, and almost committed suicide. He was rejected again in 1831 by Ellen de Vere. His proposal to Helen Marie Bayly, a country preacher's daughter, was accepted, and they married in 1833. However, Hamilton's married life was reportedly difficult.[5]

ME 581 – H02 **Name ____Lingsheng Meng____________________**

References:

[1] Macfarlane, Alexander (10 April 2015) [1916]. "Sir William Rowan Hamilton (1805–1865)". C.U. Library. Project Euclid. Historical Mathematics Monographs. Ithaca, NY: Cornell University.
[2] Wikipedia contributors. (2021, December 29). William Rowan Hamilton. In *Wikipedia, The Free Encyclopedia*. Retrieved 20:07, January 21, 2022, from https://en.wikipedia.org/w/index.php?title=William_Rowan_Hamilton&oldid=1062544524
[3] Graves, Robert Perceval (1842). "Our portrait gallery – No. XXVI. Sir William R. Hamilton". Dublin University Magazine. 19: 94–110. Archived from the original on 17 November 2017. Retrieved 13 May 2010.
[4] Dictionary of Irish Biography: Hamilton, William Rowan Archived 6 April 2019 at the Wayback Machine Cambridge University Press
[5] Bruno, Leonard C. (2003) [1999]. Math and mathematicians : the history of math discoveries around the world. Baker, Lawrence W. Detroit, Mich.: U X L. p. 209. ISBN 0787638137. OCLC 41497065.



Cyrus McCormick (Feb 1809 – May 1884)
A Biography by Michael Pagan

Cyrus Hall McCormick was born on February 15th, 1809, in Rockbridge County, Virginia. He was the oldest of eight children and grew up on a large family plantation [1]. Throughout his early years, his father, Robert McCormick, tried to develop and commercialize a horse-drawn mechanical reaper that he purchased from another man [2]. At the age of 15, Cyrus worked in the family blacksmith shop to invent a lightweight cradle for the collection of harvested grain [1]. Unlike his son, Robert McCormick was not as successful. After 30 years of work with the mechanical reaper design, he was unable to produce a reliable model. Recognizing his son's ingenuity with the cradle, Robert passed on the mechanical reaper project to Cyrus in 1831.

Cyrus McCormick used his father's work as a foundation for his design. In less than six weeks, he and his slave, Jo Anderson, successfully designed, built, and tested a horse-drawn machine that cut, thresh, and bundled grain [3]. Just three years after receiving the mechanical reaper project from his father, McCormick patented the device [2]. Rocky terrain and farmer skepticism kept sales at bay until about 1840. During the time of unpopularity, McCormick improved his design and exercised excellent business strategies to catalyze interest in the machine. By 1841, sales had grown to the point where he could no longer produce the machines from his family blacksmith shop [3]. Recognizing that the machine was most popular in the Midwest, he decided to move operations to Chicago [2].

Throughout the rise of his machine's popularity, McCormick had to address a patent dispute with Obed Hussey, an inventor who patented a mechanical reaper in 1833. McCormick claimed to have created a working model before Hussey but lost in court. When original patents expired in 1848, McCormick attempted to renew it, but again lost in court [5]. In the following years, inventors began improving the mechanical reaper design. McCormick swiftly adopted the improvements while Hussey proudly refused them. The result was increased efficacy and popularity of McCormick's mechanical reaper. In 1855, McCormick become internationally famous through his achievement of the Grand Medal of Honor at the Paris International Exposition [5]. By 1856, McCormick was selling 4000 reapers per year [2].

McCormick's success transformed the agriculture industry. According to ASME, about 75% of the U.S. labor force was connected to agriculture in 1820. By 1968, only about 5% of the labor force was connected to agriculture. McCormick's mechanical reaper was the first main-stream mechanical reaper that drastically reduced the need for farm labor. His choice of Chicago as headquarters brought unforeseen growth the once-small city. The business that McCormick built was closely tied to his family. After his son, Cyrus Jr., graduated from university, he joined the company and soon took over. Cyrus McCormick died on May 13, 1884 [1]. Through developments and acquisitions, Cyrus Jr. evolved his father's business into the International Harvester Company, which produced agricultural equipment until the 1980's.

References

[1] https://www.american-historama.org/1829-1841-jacksonian-era/mccormick-reaper.htm

[2] https://www.asme.org/topics-resources/content/cyrus-mccormick

[3] https://lemelson.mit.edu/resources/cyrus-mccormick

[4] https://www.britannica.com/biography/Obed-Hussey

[5] https://www.britannica.com/biography/Cyrus-McCormick

ME 581 – H02 **Name : Junru Pang**

Jean-Baptiste le Rond d’Alembert was a Frech mathematician, mechanician, physicist, philosopher, music theorist, and theoretical dynamicist. He was born in Paris on Nov. 16th, 1717 and Died in Paris on Oct. 29th, 1783. His most remarkable achievement is D’Alembert’s formula used to solve the wave equation. In French, the fundamental theorem of algebra is named after d'Alembert.

In July 1739, he made his first breakthrough in the mathematics field, where he discovered the errors exited in Analyse démontrée (published 1708 by Charles-René Reynaud). Around 1740, he published his second significant scientific work in the field of fluid mechanics, where he detailly discussed refraction theory.

In 1743, he finished his most famous publication, Traité de dynamique, where he concluded his own laws of motion. In 1752, he published his scholarly work called D'Alembert's paradox now, where he proposed that the drag on a body immersed in an inviscid, incompressible fluid is zero.

There are four achievements concluded below:

1: D'Alembert's equation:

$$y = xf(p) + g(p)$$

Where $p = dy/dx$..

2: d'Alembert's formula:

d'Alembet's formula is he general solution to the one-dimensional wave equation: : $u_{tt}(x,t) = c^2 u_{xx}(x,t)$.. The solution is developed by the initial conditions at $t = 0; u(x,0)\ and\ u_t(x,0)$. The solution shows:

$$u(x,t) = \frac{1}{2}[u(x-ct,0) + u(x+ct,0)] + \frac{1}{2c}\int_{x-ct}^{x+ct} u_t(\xi,0)d\xi.$$

3: d'Alembert operator

In special relativity, electromagnetism, and wave theory, the d'Alembert operator (denoted by a box), also called the d'Alembertian, wave operator, box operator, or sometimes quabla operator (cf. nabla symbol) is the Laplace operator of Minkowski space.

4: D'Alembert's principle

D'Alembert's principle, also known as the Lagrange–d'Alembert principle, is a statement of the fundamental classical laws of motion. In essence it means that any system of forces is in equilibrium if impressed forces are added to the inertial forces.

Martin Grubler
Born: 19th December 1851
Died: 31st May 1935
Sujani Patel

A German mechanical engineer famous for creating an easy mobility equation for mostly all planar and spatial mechanism. He was a professor in mechanics and applied mechanics for many years. Also has published his work called "Getriebelenhre - a theory of forced run and the planar mechanisms"

Mobility criteria used now is based on Grubler Formula. Mobility: Defined as the number of independent co-ordinates needed to define the configuration of a kinematic chain or mechanism. It is also interpreted as the number of independent actuators required to move the mechanism to its desired manner.

The formula for mobility was first derived by Grubler and later modified by Kutzbach. Grubler formulated a relation of mobility, in terms of number of links (moving and fixed) and number of joints. The equation shown below is Grubler's formula where n represents number of links with u_i representing constraints and f_i as freedoms at joint i.

$$\begin{aligned} M &= 6(n-1) - \sum u_i \\ &= 6(n-1) - \sum (6 - f_i) \\ &= 6(n-g-1) + \sum f_i \end{aligned}$$

Grubler further simplified equation for special cases like planar, one loop, two loop, spatial linkage and so.

Refrences

1. https://www.ijser.org/researchpaper/Studies-on-Gr%C3%BCblers-formula-for-mobility-and-connectivity.pdf
2. https://www.cs.rpi.edu/~trink/Courses/RobotManipulation/lectures/lecture11.pdf
3. http://users.encs.concordia.ca/~nrskumar/Index_files/Mech343/Mobility%20and%20Grashof.pdf

ME 581 - H02 Marcus Putz

Ferdinand Freudenstein
Born: May 12, 1926
Died: March 30, 2006

Ferdinand Freudenstein was born on May 12, 1926, to George Freudenstein and Charlotte Roseberg in Frankfurt Am Main. He and his family stayed there till he was about ten when they fled Germany to the Netherlands due to the Nazi party and the rise of anti-Semitism. After a short period there, they moved to England. During their time in England, the family was split up due to rising tensions in the war. Ferdinand, his mother, and two sisters left for Trinidad, ultimately ending up in New York.

While in the United Kingdom, Ferdinand was able to get a High school equivalent certificate. Using this certificate, Ferdinand applied for university in the United States, ultimately attending New York University(NYU). While only having completed two years of study at NYU, he joined the US Army for about a year and a half, where he finished his studies at the Army Specialized Training Program in Engineering at Texas A&M University. He then went on to begin his advanced degrees at Harvard, where he earned an M.S. degree in Mechanical Engineering. He then went to work in the industry for two years, working for the Instrument Division of American Optical Company. Ferdinand left to study for a Ph.D. at Columbia University.

From his job at American Optical Company and experiences from his youth, he gained a fascination with machines, which caused him to specialize in the kinematics of mechanisms. His Ph.D. dissertation is where he developed Freudenstein's equations which became an important set of equations for the world of kinematics. He later was able to set up the Ferdinand kinematics program at Columbia, where it became the place to study mechanism kinematics in the United States. He also was made Stevens Professor of Mechanical Engineering for two years where he then became the Higgins Professor. He held that position until his retirement.

[1] "Read 'Memorial Tributes: Volume 15' at Nap.edu." *National Academies Press: OpenBook*, https://www.nap.edu/read/13160/chapter/18#93.
[2] Roth, Bernard. "Ferdinand Freudenstein." *Resonance – Journal of Science Education | Indian Academy of Sciences*, https://www.ias.ac.in/describe/article/reso/015/08/0690-0698.
[3]"Image of Ferdinand Freudenstein." John Simon Guggenheim Memorial Foundation, https://www.gf.org/fellows/all-fellows/ferdinand-freudenstein/. Accessed 24 Jan. 2022.
[4] https://en.wikipedia.org/wiki/Ferdinand_Freudenstein

A Biography of Robert Stawell Ball
1 July 1840 – 25 November 1913

Son of a civil servant and a naturalist, named Robert Ball Sr. and Amelia Gresley Hellicar, Robert Ball Jr. was the second of his parents' seven children, his brothers and sisters being Valentine, Charles, Kate, Mary, Amelia and Annie. Robert went to Dr John Lardner Burke's School in Dublin, then later at Dr Brindley's school in Tarvin. Robert Ball Sr. died in March 1857 and Ball returned from Leamington Spa to Ireland to help his family financially.

Shortly after this, on 13 October Ball entered Trinity College, Dublin, to study mathematics and science with a scholarship in 1860.

Ball was an outstanding student at Trinity College, Dublin, winning gold medals and prizes.

After being assistant astronomer and tutor at Birr Castle from 1865 to 1867 he was appointed Professor of Applied Mathematics at the Royal College of Science in Dublin. His excellent lectures on Experimental Mechanics were published in 1871. In 1874 Ball was appointed Royal Astronomer of Ireland and Andrews Professor of Astronomy in the University of Dublin at Dunsink Observatory. He became Lowndean Professor of Astronomy and Geometry at Cambridge University in 1892.

In around 1864 Ball worked as a tutor for Rosse's children in exchange for observation time with reflecting telescope at Birr Castle. With this telescope he discovered six previously unknown nebulae which were listed in the New General Catalogue. Also while he was at Birr he observed the Leonid meteor shower on night of 13-14 November 1866. After two years working for Rosse, Ball was offered the chair of applied mathematics and mechanics in the Royal College of Science in Dublin which had recently been founded. There, Ball developed vivid physical demonstrations and laid the foundation of a successful style of lecturing that was to earn him fame in later years.

In 1868 he married Frances Elizabeth Steele from Dublin, whose father was registrar of the Royal Dublin Society and had been a friend of Ball's father. They had four sons and two daughters.

The main mathematical topic on which Ball did research was dynamics, in particular the theory of screws. Screw theory provides a mathematical formulation for the geometry of lines which is central to rigid body dynamics, where lines form the screw axes of spatial movement and the lines of action of forces. His work was highly regarded and he was elected a Fellow of the Royal Society in 1873. He was further honored for his mathematics when The Theory of Screws: A Study in the Dynamics of a Rigid Body , which was published in 1876, was awarded Cunningham medal of the Royal Irish Academy in 1879.

He died 25 November 1913 at his home in the Cambridge University observatory after a long illness; his funeral took place after a special service in King's College chapel.

References:

1. https://www.askaboutireland.ie/reading-room/life-society/science-technology/irish-scientists/robert-stawell-ball-frs-(/

2. https://mathhistory.st-andrews.acc.uk/Biographies/Ball_Robert/

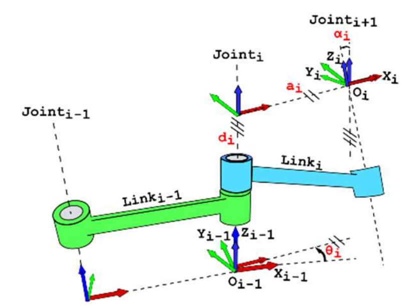
3. https://www.dib.ie/biography/ball-sir-robert-stawell-a0352

Jacques Denavit

(1930-2013)

Denavit was born in Paris, France on Oct. 1, 1930 to Georges and Marie (Arnould) Denavit. He married Catherine Dahlinger of Nashville, Tenn. in 1954 and they raised three children in Evanston, Ill. In 1952, Denavit completed a degree in general mathematics and physics from the University of Paris and then received a master of science degree in electrical engineering from Northwestern University in 1953 and a Ph.D. in mechanical engineering from Northwestern University in 1956. [1] He was a professor of mechanical and nuclear engineering at Northwestern University from 1958-82, a research physicist in the Plasma Physics Division at the Naval Research Laboratory from 1969-71 and a research physicist at Lawrence Livermore National Laboratory from 1982-93. [2] Denavit co-authored Kinetic Synthesis of Linkages with Richard Hartenberg (1964); this work introduced the mathematics still used today for describing robotic motion that bears his name, Hartenberg-Denavit parameters. [3]

Figure 1. Hartenberg-Denavit Homogenous Transformation Matrix and parameters



$$
{}^{n-1}T_n = \left[\begin{array}{ccc|c} \cos\theta_n & -\sin\theta_n\cos\alpha_n & \sin\theta_n\sin\alpha_n & r_n\cos\theta_n \\ \sin\theta_n & \cos\theta_n\cos\alpha_n & -\cos\theta_n\sin\alpha_n & r_n\sin\theta_n \\ 0 & \sin\alpha_n & \cos\alpha_n & d_n \\ \hline 0 & 0 & 0 & 1 \end{array}\right]
$$

- d : offset along previous z to the common normal
- θ : angle about previous z, from old x to new x
- r : length of the common normal (aka a, but if using this notation, do not confuse with α). Assuming a revolute joint, this is the radius about previous z.
- α : angle about common normal, from old z axis to new z axis

Regarded as a pioneer in the computer simulation of plasmas, he published numerous scientific articles and was honored by being named a Fellow of the American Physical Society. At Lawrence Livermore National Laboratory, Denavit made important contributions to the fields of inertial confinement fusion and high intensity short pulse laser-matter interaction. He also conducted innovative research that significantly contributed to the national security mission of the Laboratory. Highly respected by his colleagues, Denavit was an advisor to Laboratory leadership and mentor to younger colleagues.

A memorial for Denavit was held at his home in Pleasanton on Sept. 14 with immediate family members in attendance. Memorial donations may be given to a charity of choice.

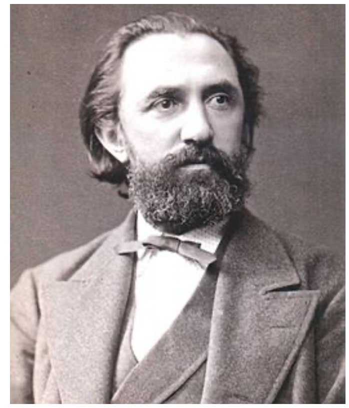
[1]. https://www.llnl.gov/community/retiree-and-employee-resources/in-memoriam/jacques-denavit

[2]. https://www.northwestern.edu/magazine/spring2014/alumnilife/passings.html

[3]. https://en.wikipedia.org/wiki/Denavit%E2%80%93Hartenberg_parameters

Quentin Vaira

Franz Reuleaux (1829-1905)



Franz Reuleaux was born in Eschweiler (1829) which is located in the western part of Germany near the border with Belgium. He had a hands-on knowledge of machines that was influenced by initially following in the footsteps of his father and grandfather who were both machine builders. The family business was originally located in Liege, Belgium then moved to Eschweiler in the early 19th century prior to Reuleaux being born. Belgium was one of the first countries in Europe that was industrialized in the 18th century and his family built steam engines used in the coal and mining industry.

At the age of 21, Reuleaux attended the Polytechnic University of Karlsuhe for two years (1850-52). He received technical training in Civil Engineering (ME was not yet a separate discipline) from the renowned machine theorist, Professor Ferdinand Redtenbacher. He then attended other universities in Berlin & Bonn (Germany) for a period of time then returned to operate the family business after the death of his father. At the age of 27 (1856) he got a job as a mechanical engineering professor at the Swiss Federal Institute in Zurich, Switzerland. In 1864 he returned to Germany to develop a mechanical engineering program at the Royal Industrial Academy in Berlin.

Reuleaux was considered an engineer-scientist and a strong advocate for designing machines using a scientific approach supported by mathematical analysis. Although he had a hands-on background, he did not agree with the craftsman-engineer style using the trial-and-error approach. He believed machines should evolve with each iteration pushing the operating boundaries of the previous version. His vision for the emerging *Mechanical Engineering* discipline influenced the development of academic curriculum in the later part of the 19th century.

Reuleaux co-authored his first book in 1854, *Design for Mechanical Engineering*. In 1861, he published *Der Constructeur* (or *The Designer*) and by its 4th edition contained over 1200 illustrations. He complimented the books by building over 800 kinematic physical models with many intended to be used with his book, *Kinematics of Machinery (1875)*. An example is the "Ellipsenzirkel" which is a double slider mechanism that can draw a perfect ellipse. He is credited with the Reuleaux triangle which creates curves with constant width. An item using this concept is a machine tool that can fabricate square holes. He was intrigued with devices that draw straight lines, creating 39 different straight line mechanism models.

Reuleaux contributed to the study of kinematics by treating machine elements as a series of connected parts (pairs) called a kinematic chain. The motion of each part is constrained by the neighboring part giving rise to the term *kinematic pairs*. His development of constraints and geometry topology provided the tools and techniques to perform kinematic synthesis. Reuleaux also developed an extensive collection of symbols to represent machine mechanisms intended to be used as language for machine design. He contributed to the Otto-Langen internal combustion engine and thoroughly documented rotary engine designs made by others in his time period.

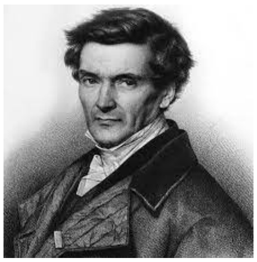
Reuleaux was an important historical theoretical Kinematician. One of the largest collections of his models is the *Reuleaux Collection of Mechanisms and Machines* which can be viewed online at Cornell University Kinematic Models for Design Digital Library.

References:

1. *Franz Reuleaux*: *Contributions to 19th C. Kinematics and Theory of Machines* by Francis C. Moon (2002)
2. Cornell Reuleaux Collection of Kinematic Models, Cornell University (www.mae.cornell.edu/mae/facilities/reuleaux-collection)
3. Wikipedia (en.wikipedia.org/wiki/Franz_Reuleaux)

ME 581 – H02 **Name:** Dave Warner

Gaspard Gustave de Coriolis: A Bibliography
May 21, 1972 – September 19, 1843



Gaspard Gustave de Coriolis (G. Coriolis) was born in Paris, Frace to Jean-Baptiste-Elzéar Coriolis and Marie-Sophie de Maillet. His father was a sub-lieutenant in the Bourbonnais regiment in 1773 and fought with French forces supporting the American side in the Revolutionary War in 1780. Upon returning to France, he was promoted to captain in 1784 and later served as an officer under King Louis XVI. Amisdt the turmoil of the French Revolution and subsequent capture and execution of King Louis, Jean-Baptiste-Elzéar's ties to the monarchy made his living in Paris rather dangerous. In September 1792, shortly after Coriolis' birth, his family fled to Nancy, France. It was here where Coriolis spent his early developmental and educational years.

In 1808 Coriolis applied to the École Polytechnique in Paris. Coriolis placed second of all incoming students on the school's entrance examination. Coriolis studied friciton and hydraulics while attending the school. Upon graduation, Coriolis entered École des Ponts et Chaussées (School of Bridges and Roads) in Paris. Here he joined the engineering corps and spent several years in the Vosges mountains with engineering teams assigned to public works projects.

Following his father's death and his own health problems, Coriolis returned to École Polytechnique in 1816 to tutor analysis. He was recommended for position by famous mathematician, Augustin-Louis Cauchy. This pivoted Coriolis' career away from engineering and towards mathematical and physical research. Inspired by research in militart artillary, Coriolis spent years working on the now famous publication Du Calcul de l'effet des machines (On the Calculation of Mechanical Action), which coined the modern terms of work and kinetic energy.

After 1829 publication, Cauchy offered Coriolis a position at École Centrale des Artes et Manufactures (Central School of Arts and Manufacturing) as a mechancis professor. Coriolis later left the institution to focus on his own research. During this time, Coriolis investigated the internal forces acting on a rotating surface. His research culminated in 1835 when he issued his most famous paper, Sur les équations du mouvement relatif des systèmes de corps, which showed the laws of motion could be used in a rotating frame of reference if an extra force (the Coriolis acceleration) is added to the equations of motion. This internal force acts normal to the rotating surface with respect to the direction of motion, causing a curved path of motion.

References

[1] Gaspard Gustave de Coriolis. (2010). In Encyclopedia of World Biography Online (Vol. 30). Gale. https://link.gale.com/apps/doc/K1631009389/GIC?u=psucic&sid=summon&xid=1d035f2a

[2] O'Connor, J. J., & Robertson, E. F. (2000, July). *Gaspard Gustave de Coriolis*. Retrieved from https://mathshistory.st-andrews.ac.uk/Biographies/Coriolis/

[3] A Dictionary of scientists. (1999). Oxford University Press.

Michael Chasles

November 15, 1793 – December 18, 1880

Michel Chasles was a renowned geometer who made significant contributions in the field of projective geometry. He published many solutions in French academic journals, wrote textbooks on the subject, and received the prestigious Copley in 1865 for "…his historical and original researches in pure geometry." He is one of 72 scientists whose names are engraved on the first floor of the Eiffel Tower in Paris, France.

Chasles was born just outside of Chartres, France on November 15, 1793 to parents Charles Henri Chasles and Catherine Emilie Hardoun. Michel was not his name given at birth, Chasles was christened Floréal and was not legally named Michel until after his sixteenth birthday. His early studies occurred at Lycée Impérial until he enrolled in École Poltechnique in 1812. His higher education was relatively short-lived as he was mobilized (drafted) into the French army in 1814, taking part in the defense of Paris. After the war, Chasles initially returned to study, but would forsake his formal education for a position in a stock brokerage firm, which he eventually failed at. After his time at a brokerage firm Chasles would retire to his home region to devote himself to mathematical and historical (often mathematical history) studies.

Chasles would see his first major work published in 1837, titled *Aperçu historique sur l'origine et le développement des méthodes en géométrie* ("Historical view of the origin and development of methods in geometry") which focused on the method of reciprocal polars in projective geometry. This work garnered enough academic acclaim that he was offered a professorship at École Polytechnique. By 1846 The Sorbonne had created the position of chair of higher geometry specifically for Chasles, a position he retained until his passing in 1880. He would continue to write and publish many academic works and texts throughout the rest of his life, the most impactful of which is most likely *Traité de géométrie* ("Treatise on Geometry"). In this text Chasles introduces geometric cross ratios, pencils, and involutions. A follow up text *Traité des sections coniques* ("Treatise on Conic Sections") applied these concepts to conic sections. This text is what eventually lead to the Royal Society of London to award Michel Chasles the Copley Medal.

Throughout his life, Chasles was elected to many academic societies that spanned the globe. He is celebrated for original contributions in the field projective geometry. He was widely respected for his ability to not only think originally with regards to mathematical proofs, but also view mathematical studies through a historical lens.

Bibliography

O'Connor, J J, and E F Roberston. “Michel Chasles - Biography.” *Maths History*, July 2000, https://mathshistory.st-andrews.ac.uk/Biographies/Chasles/.

“Complete Dictionary of Scientific Biography.” Encyclopedia.com. 25 Jan. 2022 .” *Encyclopedia.com*, Encyclopedia.com, 26 Jan. 2022, https://www.encyclopedia.com/science/dictionaries-thesauruses-pictures-and-press-releases/chasles-michel.

“Michel Chasles.” *Encyclopædia Britannica*, Encyclopædia Britannica, Inc., 20 July 1998, https://www.britannica.com/biography/Michel-Chasles.

A Brief Overview of Leonhard Euler's (April 15, 1707 - September 18, 1783) Life

By: Evan West

Leonhard Euler was the oldest of Paul Euler and Marguerite Brucker's four children. Leonhard was born in Switzerland where he spent his childhood receiving math lessons from his father who studied math while pursuing a theology degree. Leonhard showed interest and extreme abilities in the field of mathematics and graduated with a Masters of Philosophy at the age of 16.

Euler spent the majority of his career at either the St. Petersburg Academy of Sciences in Russia or the Berlin Academy in Prussia where he went on to make many revolutionary discoveries. Some of these accomplishments include solving the Basel problem and refining work of previous scholars such as Isaac Newton with a more mathematical lens. Some of Euler's most lasting work came in the area of differential calculus which laid the groundwork for all subsequent discoveries.

Leonhard Euler is most widely known for his popularization of many math terms we use today. Euler's number, "e", corresponds to the value 2.71828. While he popularized using the Greek letter pi to represent 3.14159…, he was also the first to introduce the letter i equating to the square root of -1, as well as the notation f(x) corresponding to "a function of x". Euler simplified the area of complex numbers, but he also related them with useful exponential and trigonometric functions. This list of contributions could continue on for pages, but it is clear that Leonhard Euler made an everlasting impression on mathematics and how we study it today.

References

https://mathshistory.st-andrews.ac.uk/Biographies/Euler/
https://www.britannica.com/biography/Leonhard-Euler
https://www.famousscientists.org/leonhard-euler/