Essential Highlights of the History of Fluid Mechanics

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ABSTRACT

To achieve accreditation, engineering and technology programs throughout the United States must meet guidelines established by the Accreditation Board for Engineering and Technology (ABET). One of these requirements is that departments demonstrate that they provide students with an understanding of engineering in a broad, societal context. Examination of engineering history can be an essential element to this endeavor, because the development of modern theories and practices have diverse and complex evolutions which are often intimately intertwined with the development of societies themselves. Fluid mechanics is a key field of engineering, whose body of knowledge has had a significant influence on the design and operation of many products and systems over the centuries. Because of this, fluid mechanics coursework is often required for many engineering and technology majors and can, in fact, represent a key component to these programs. Toward these ends, this paper will discuss highlights from the history of fluid mechanics, and will provide several timelines that summarize key scientists, theories, events, equipment and machines. Considering fluid mechanics in this manner can achieve the goal of placing this branch of engineering in an appropriate societal context. It is always a challenge for educators to find useful and interesting material on history; therefore, a summary list of conventional and online resources will also be included. As such, this paper can be used as a resource for both engineering as well as history educators to supplement existing coursework.

Keywords
Curriculum Development, Engineering, Fluid Mechanics, History, Society, Technology

INTRODUCTION

As with many fields of modern scientific study, fluid mechanics is rooted in the history of humanity. Over time, as humans adapted and evolved, and their knowledge and skills increased, specific scientific and technological disciplines arose. Many modern conveniences which are now often taken for granted actually originated centuries ago, as have the theoretical foundations upon which they were developed. Throughout its history, fluid mechanics has been a field that has constantly advanced. Inquiry has progressed from trial and error, to formal experimentation, to mathematical theory. As with other engineering fields, it has now reached the point of scientific maturity, with most of the fundamentals clearly understood. As such, it has become a vital component for many engineering curricula. It is therefore a very useful exercise to examine the historical development of this discipline.

HISTORICAL DEVELOPMENTS

The development of the field of fluid mechanics, as with many other disciplines, is best examined within the context of the history of humans, which, for the purposes of this paper, can be conveniently categorized according to five major historical periods, including antiquity, Classical Civilization, the Middle Ages, the Renaissance through the Industrial Revolution, and the modern (i.e., post-Industrial Revolution). A brief, but thorough introduction to this history is provided by Munson et al. (2003). Tokaty (1971) provides a very comprehensive historical narrative.

During Antiquity (prior to approximately 500 B.C.), applications of fluid mechanics were solely for practical purposes, such as water distribution systems for the irrigation of agricultural crops. In fact, the cradles of civilization developed near river valleys primarily because of readily accessible supplies of water. Irrigation systems greatly expanded the surrounding lands and made them available for food cultivation. Additionally, early civilizations utilized water systems for the development of cities. For example, the Harrapan people of the Indus River Valley developed city-wide drainage systems to collect rainwater, and all houses had indoor plumbing and toilet facilities with connected sewer systems. Peoples during this time period also constructed crude rafts and boats, but over time developed highly sophisticated ships and barges. For instance, the Egyptians transported great quantities of massive stones on the Nile River in order to construct the pyramids.

During Classical Civilization, which lasted from approximately 500 B.C. to A.D. 500, and centered on the Greek and Roman Empires, many large-scale public works projects were constructed as cities reached new levels of complexity and style. Some of these projects included large bath houses, sewer systems, water distribution systems, and most prominently, the large aqueducts which transported water into Rome from distant water supplies such as rivers and lakes. During this time, many philosophers and mathematicians began theorizing and investigating the nature of objects, including fluids, in order to understand the world in which they lived.

The Middle Ages (approximately A.D. 500 to 1400) witnessed little development in the knowledge base of fluid mechanics, as was the case with most scientific pursuit during this time. On the other hand, waterwheels and windmills became quite prevalent during this time as means to power mills and other mechanical devices, and boat and ship construction evolved and progressed. At the end of the Middle Ages, European countries had developed advanced ocean-going vessels, and were about to embark upon global exploration.

During the Renaissance and Industrial Revolution, which lasted from approximately A.D. 1400 to 1900, a renewed interest in understanding and describing the nature of objects, including fluids, rapidly spread. Formal experimentation began to be used to facilitate these endeavors. Mathematical systems were developed to help describe the phenomena and the behaviors which were observed. Mathematic quantification thus led to the development of theory. During the Industrial Revolution, many devices were invented that utilized many of the principles that had been determined, especially machines that utilized fluid flow for the transfer of power.

During the modern age (approximately A.D. 1900 onward) the development of the airplane, two world wars, and the Cold War, not to mention the advent of the digital computer as well as computational fluid dynamics software, drove much of the developments in fluid mechanics, especially in the fields of aerodynamics and aeronautics.

Timelines are often used to summarize the progression of historical events. To make the rich history of the field fluid mechanics more accessible to both educators as well as students, the development of this discipline has thus been delineated according to key people who developed ideas and theories (Table 1), the ideas and theories themselves (Table 2), and significant inventions and events throughout history (Table 3).

Table 1. Key people in the history of fluid mechanics.

Lifespan		Person
287 – 212	B.C.	Archimedes
40 – 103	A.D.	Sextus Julius Frontinus
1452 – 1519		Leonardo da Vinci
1564 – 1642		Galileo Galilei
1608 – 1647		Evangelista Torricelli
1623 – 1662		Blaise Pascal
1642 – 1727		Isaac Newton
1695 – 1771		Henry de Pitot
1700 – 1782		Daniel Bernoulli
1707 – 1783		Leonhard Euler
1717 – 1783		Jean le Rond d'Alembert
1718 – 1798		Antoine Chezy
1746 – 1822		Giovanni Battista Venturi
1785 – 1836		Louis Marie Henri Navier
1789 – 1857		Augustin Louis de Cauchy
1797 – 1884		Gotthilf Heinrich Ludwig Hagen
1799 – 1869		Jean Louis Poiseuille
1802 – 1870		Heinrich Magnus
1803 – 1858		Henri Philibert Gaspard Darcy
1806 – 1871		Julius Weisbach
1810 – 1879		William Froude
1816 – 1897		Robert Manning
1819 – 1903		George Gabriel Stokes
1829 – 1908		Lester Pelton
1838 – 1916		Ernst Mach
1842 – 1912		Osborne Reynolds
1842 – 1919		Lord Rayleigh (John William Strutt)
1850 – 1922		Vincenz Strouhal
1867 – 1940		Edgar Buckingham
1871 – 1951		Moritz Weber
1875 – 1953		Ludwig Prandtl
1880 – 1953		Lewis Ferry Moody
1881 – 1963		Theodor von Karman
1883 – 1970		Paul Richard Heinrich Blasius

Table 2. Key theories in the history of fluid mechanics.

Date		Theoretical Development
390	B.C.	Plato, a Greek philosopher, describes the origins of rivers as water escaping through holes in the ground
250		Archimedes publishes "Floating Bodies" in which he discusses the principles of buoyancy and hydrostatics
200		Chinese scholars discover that tides are connected to the lunar cycle
100		Greek philosopher Poseidonius discovers tides are connected to the lunar cycle
1643	A.D.	Evangelista Torricelli develops the relationship between pressure and velocity of fluids for free jets
1738		Daniel Bernoulli publishes "Hydrodynamica" which discusses the pressure and velocity of fluids, and delineates the Bernoulli equation
1768		Antoine Chezy develops relationships for open channel flow
1839		Gotthilf Heinrich Ludwig Hagen describes laminar flow properties
1840		Jean Louis Poiseuille describes laminar flow properties
1850		Rudolf Clausius develops kinetic theory of gases
1877		J. Boussinesq describes eddy viscosities in turbulent flows
1883		Osborne Reynolds describes the differences between laminar and turbulent pipe flow
1889		R. Manning develops a modified equation describing open channel flow
1891		Samuel Langley publishes "Experiments in Aerodynamics"
1895		Osborne Reynolds describes turbulent shear stresses
1904		Ludwig Prandtl develops solution to Navier-Stokes equations for boundary layer flow
1908		Paul Richard Heinrich Blasius develops solution to boundary layer equations for flow past a flat plate
1918		Ludwig Prandtl develops theory of flow over airplane wings
1919		Robert Goddard publishes "A Method of Reaching Extreme Altitudes"
1921		Hermann Oberth publishes "The Rocket into Interplanetary Space"
1933		J. Nikuradse describes relationships between pipe flow, friction factor, and Reynold's Number
1944		L. Moody summarizes relationships between pipe flow, friction factor, and Reynold's Number, and develops the Moody Chart

Table 3. Key inventions and events in the history of fluid mechanics.

Date		Historical Development
> 3000	B.C.	Civilizations begin to develop when nomadic tribes settle near river valleys and begin cultivation of land
3000		Irrigation channels are used throughout Mesopotamia and Egypt The Harrapans in the Indus River Valley build brick-lined cities, wells, and city-wide drainage systems Most Harrapan homes have indoor toilets Egyptians develop reed boats to travel throughout the Mediterranean
2300		400 feet wide, 200 mile long Nahrawan Canal is constructed to connect the Tigris and Euphrates Rivers, used for navigation and irrigation
2000		The shadoof, a pivoting pole with a water bucket at one end and a weight at the other, is developed in Mesopotamia to lift water for irrigation
2000 – 1500		Egyptians develop irrigation systems utilizing water from the Nile River Dams constructed in India to control water
1820		A canal is dug between Lake Moeris and the Nile River to control flooding
1700		Windmills are in use in Babylon, they are used to pump water for irrigation
1500 – 1000		Shipbuilding arts reach advanced state in Mediterranean countries
1450		200 feet long barges are constructed by the Egyptians to transport obelisks on the Nile River
1400		Commercial shipping fleets operate around the Greek isles The water clock (clepsydra) is in use in Egypt
1300		20 feet high dam is constructed on the Orontes River in Syria by filling the river with rock
1000 – 900		Subterranean water supply system constructed under Jerusalem
800		Underground qanats (aqueducts) are drilled into Persian hills to find groundwater Chinese invent a cart which is powered by steam
750		50 feet high, 1970 feet long Marib dam is constructed in Yemen to provide water for irrigation, it operates for over 1000 years
700		6 feet wide, 1750 feet long tunnel is constructed through solid rock to transport water from the Gihon Spring to Jerusalem 80 feet long bireme boats are constructed by the Greeks
700 – 600		Egyptian Pharaoh Nechos constructs a canal between Nile River and Red Sea Water clocks in use in Assyria
691		66 feet wide, 50 mile long Jerwan aqueduct is constructed to transport water from the Greater Zab River to Nineveh in Assyria
600 – 500		Construction of ¾-mile long water supply tunnel on Greek island of Samos Theodorus of Samos develops the water level Water supply system constructed in Athens, Greece, it consists of a well

		with nine distribution pipes
590		Rome's drainage system is designed by its king Tarquinius Priscus Rome's Great Sewer (Cloaca Maxima) is constructed by lining a river bed with stone
535		Samos Tunnel aqueduct is constructed on Samos island, it is 6 feet in diameter and 3300 feet long through solid rock
500 – 450		Many dams are constructed in India
475		Two-masted ships are in use around Mediterranean
400		First rain gauges used – in India Chinese first to burn oil as energy – for cooking of food
350		Cities in Greece and Sparta use underground pipes to carry hot air to heat buildings Construction begins on the southern portion of the Grand Canal Aristotle writes about primitive diving bells
347		Bamboo pipes are used in China to transport methane gas for lighting
312		Aqua Appia aqueduct, the first of several in Rome, is constructed to transport water 9.9 miles to Rome from the Sabine Hills
310		Chinese develop double-acting bellows to produce continuous air supply for smelting metals
300		The noria, which is a vertical water wheel with buckets, is developed in Mesopotamia to lift water for irrigation Rome develops an underground building heating system using piping for transport of hot air, similar to that in Sparta and Greece Wet rice is cultivated in Japan
250		Archimedes develops the Archimedes Screw to remove water from ships
245		Egyptian warships achieve 400 feet in length, and require 4000 rowers
211		Chinese drill first natural gas well, use bamboo pipes, 460 feet deep
200		Ox-powered water wheels are used to move water for irrigation Roman shipbuilders construct ships with three masts
159		The clepsydra (water clock) is first used in Rome
144		Aqua Marcia aqueduct in Rome is completed, it brings water 57 miles from the Anio River
125		Aqua Tepula aqueduct in Rome is completed, it brings water from the Alban Hills
100		Greeks install a weather vane on the Acropolis, and are the first to measure wind direction
85		Water wheels used in Greece to power mills
33		Aqua Julia aqueduct in Rome is completed
19		Aqua Virgo aqueduct constructed in Rome to supply public bath houses
2		20-mile Aqua Alsietina aqueduct constructed to bring water from Alsietinian Lake to the Naumachia basin in Rome for mock sea battles
30	A.D.	Water wheels are used in China to power bellows to forge agricultural equipment

700		Water wheels are used throughout Europe to power mills
900		Shipbuilding arts are developed by the Vikings in Scandinavia
1090		Water-driven mechanical clocks are developed in Beijing, China
1180		Windmills first used in Europe
1432		Portuguese have developed the caravel ocean-going ship Gonzalo Cabral (Portugal) discovers the Azores islands Beginning stages of European naval expeditions and expansion
1480		Leonardo da Vinci develops the first parachute
1490		Leonardo da Vinci investigates capillary movement of liquids in small tubes
1510		Leonardo da Vinci develops the first turbine water wheel
1512		British develop double-decked ships
1514		European ships reach China
1535		Diving bells in use for first time
1543		Blasco da Garay (Spain) designs the first steamboat
1582		City waterworks system is constructed in London
1592		Windmills are used to power saw mills in Holland
1596		Galileo Galilei develops the first thermometer
1598		Iron-clad warships are developed in Korea
1619		William Harvey (England) discovers circulation of blood in the body
1624		Johannes Baptista van Helmont (Belgium) refers to compressible fluids as “gas”
1643		Evangelista Torricelli (Italy) develops the barometer to measure air pressure
1652		Otto von Guericke (Germany) develops the air pump
1661		Christian Huyghens (Holland) develops the manometer to measure gas pressure
1670		Giovanni Borelli (Italy) develops artificial wings and attempts to fly
1672		Jan van der Heyde develops flexible hoses for fire fighting
1690		Denis Papin (France) designs a piston pump powered by steam
1707		Denis Papin (France) designs a high-pressure boiler
1714		Daniel Gabriel Fahrenheit develops the mercury thermometer with the Fahrenheit temperature scale
1742		Anders Celsius (Switzerland) designs a thermometer with the Centigrade temperature scale
1764		James Watt develops the steam condenser
1766		Henry Cavendish discerns density differences between hydrogen and air
1775		Pierre-Simon Girard develops a water turbine James Watt develops the steam engine
1778		John Smeaton develops improved diving bells
1782		Montgolfier brothers develop the hot air balloon James Watt develops the double-acting rotary steam engine
1787		John Fitch (US) develops a steamboat, and sails on the Delaware River
1795		Joseph Bramah develops the hydraulic press
1800		Richard Trevithick develops a light-pressure steam engine
1801		Robert Fulton (US) develops the first submarine

1803		Robert Fulton (US) develops a steam-powered boat
1805		Rockets are first used as military weapons in British army
1811		Ludwig Berblinger (Germany) attempts to fly using artificial wings
1812		Henry Bell develops a steam-powered ship
1815		US develops first steam-powered warship – U.S.S. Fulton
1827		Josef Ressel (Austria) develops a screw propeller for ships Sand filters used in London's water supply system
1829		Josef Ressel (Austria) develops steamship with screw propeller that can reach speeds of six knots
1830		Steam-powered street cars are in use throughout London
1845		William McNaught (England) develops a compound steam engine
1859		Construction of Suez Canal, to connect Mediterranean Sea to Red Sea, begins
1860		Etienne Lenoir develops an internal combustion engine
1865		First oil pipeline constructed in US in Pennsylvania
1871		Simon Ingersoll (US) develops a pneumatic drill for rock drilling
1872		George Westinghouse (US) develops air brakes for rail cars
1875		London's sewer system is constructed
1884		Charles Parsons develops the first steam turbine engine
1885		Karl Benz (Germany) develops a single-cylinder engine for automobiles
1888		John Dunlop (US) develops the pneumatic (air-filled) tire for automobiles
1892		Rudolf Diesel develops an internal combustion engine
1893		Henry Ford (US) manufactures his first car Karl Benz (Germany) manufactures his first car
1895		Konstantin Isiolkovski develops the theory of rocket propulsion
1898		Ferdinand von Zeppelin develops first airship
1903		Orville and Wilbur Wright (US) conduct first successful airplane flight Henry Ford establishes Ford Motor Company
1908		General Motors Company established
1909		Henri Farman (England) completes first 100-mile airplane flight
1912		Royal Air Force established in England S.S. Titanic sinks 1st successful parachute jump
1913		Rene Lorin develops theory of jet propulsion
1914		Robert Goddard (US) experiments with, and successfully develops, rockets
1915		Hugo Junkers develops first airplane for air combat
1919		Jakob Bjerknes develops theory of cyclones as waves between air masses J. Alcock and A. Brown conduct first nonstop transatlantic flight in an airplane
1920		Anton Flettner (Germany) develops metal-sailed rotor ships
1926		Robert Goddard tests first rocket powered by liquid fuel
1927		Charles Lindbergh flies "Spirit of St. Louis" from New York to Paris World's deepest well is drilled in California, it is 8000 feet deep

1928		Amelia Earhart conducts first flight by a woman over the Atlantic
1931		Percy Bridgeman (US) experiments with high pressures
1936		Hoover Dam in Nevada / Arizona is completed Hindenburg airship completes first transatlantic flight
1937		Bonneville Dam in Oregon is completed Frank Whittle develops first jet engine Hindenburg airship explosion
1938		Bartlett Dam in Arizona is completed
1940		Vought-Sikorsky Corporation conducts first helicopter flight Tacoma Narrows suspension bridge in Washington collapses
1942		Max Muller develops the turbo prop aircraft engine Bell Aircraft develops first US jet airplane
1943		1300-mile oil pipeline from Texas to Pennsylvania is constructed
1946		Rocket missiles are developed in the US
1947		First supersonic airplane flight
1948		US missiles can achieve 3000 miles per hour speed and 78 mile altitude
1949		US missiles can achieve 250 mile altitude
1953		US airplane achieves speeds of 1600 miles per hour
1957		USSR launches Sputnik I and Sputnik II artificial satellites
1958		US launches Explorer I artificial satellite USSR launches Sputnik III artificial satellite US establishes National Aeronautics and Space Administration (NASA)
1959		USSR launches a rocket with two monkeys as passengers USSR launches Lunik to moon USSR launches Lunik III to photograph moon
1960		US airplane achieves speed of 2200 miles per hour
1961		Yuri Gagarin (USSR) orbits earth Alan Shepard (US) achieves first US space flight
1963		Michael DeBakey is first surgeon to use an artificial heart to pump a patient's blood during heart surgery
1964		US launches Ranger VII to photograph moon
1966		Michael DeBakey is first surgeon to use plastic artificial artery implants USSR launches Luna 9 to the moon US launches Surveyor I to the moon
1968		Aswan Dam in Egypt is completed
1969		England and France develop the commercial supersonic Concorde airplane First humans land on moon during Apollo 11 mission (US)
1974		US SR-71 airplane flies at 2000 miles per hour during 55-minute transatlantic flight
1977		First US space shuttle "Enterprise" completes test flight
1986		Dick Rutan and Jeanna Yeager complete first nonstop flight around the world in airplane "Voyager"

RESOURCES FOR INSTRUCTORS

For instructors who are interested in augmenting existing fluid mechanics coursework with appropriate historical perspectives, supporting teaching materials are absolutely essential to success. Therefore, in addition to the timelines presented in this paper, an extensive listing of both recent books as well as current websites is provided below. These contain much historic information that instructors should find useful. Although only a few books have been found that specifically discuss the history of fluid mechanics and the applications of this discipline (a large number of books dedicated to the history of the airplane are currently available, but only a small fraction are actually listed here), many websites are currently available. To facilitate their use, the websites have been categorized under several broad themes, including general history of fluid mechanics, history of mathematics and science, historical figures, history of aviation and aeronautics, and history of computational fluid dynamics.

Books

Anderson, J. D., M. J. Rycroft, W. Shyy. 1997. A History of Aerodynamics and Its Impact on Flying Machines. Cambridge University Press.

Chant, C. C. and J. Batchelor. 2002. A Century of Triumph: The History of Aviation. Free Press.

Chanute, O. and A. Frost. 1998. Progress in Flying Machines. New York, NY: Dover Publications.

Hansen, J. R. 2003. The Bird Is on the Wing: Aerodynamics and the Progress of the American Airplane. Texas A&M University Press.

Lilienthal, O. 2000. Birdflight as the Basis of Aviation. Markowski International.

Ogle, M. 2000. All the Modern Conveniences: American Household Plumbing, 1840-1890. Johns Hopkins University Press.

Tokaty, G. A. 1971. A History and Philosophy of Fluid Mechanics. New York, NY: Dover Publications, Inc.

Vivian, E. C. 2003. A History of Aeronautics. Indy Publishing.

Wegener, P. P. 1991. What Makes Airplanes Fly? History, Science, and Applications of Aerodynamics. Springer-Verlag.

Websites

General History of Fluid Mechanics

Highlights in the History of Hydraulics – Hunter Rouse, The University of Iowa
http://www.lib.uiowa.edu/spec-coll/Bai/hydraul.htm

Historical Graphics and The History of Hydraulics Book Collection – Hunter Rouse, The University of Iowa
http://www.iihr.uiowa.edu/products/history/hoh/index.html

Hydrodynamic Turbulence: a 19th Century Problem with a challenge for the 21st Century - Victor L'vov and Itamar Procaccia Department of Chemical Physics, The Weizmann Institute of Science, Israel
http://lvov.weizmann.ac.il/physword/physword.html

Sketching the History of Statistical Mechanics and Thermodynamics – Jeff Biggus, HyperJeff Network

http://history.hyperjeff.net/statmech.html

History of Mathematics and Science

Mathematicians of the Seventeenth and Eighteenth Centuries – David R. Wilkins, School of Mathematics, Trinity College, Dublin, Ireland
http://www.maths.tcd.ie/pub/HistMath/People/RBallHist.html
Museum of the History of Science – Oxford, England
http://www.mhs.ox.ac.uk/
The MacTutor History of Mathematics Archive – University of St. Andrews, Scotland
http://www-history.mcs.st-and.ac.uk/~history/
World of Scientific Biography – E. Weisstein, Wolfram Research
http://scienceworld.wolfram.com/biography/

Historical Figures

Daniel Bernoulli and the Making of the Fluid Equation – D. Quinney, Keele University
http://pass.maths.org.uk/issue1/bern/index.html
Dr. Theodore von Karman – Ace Flyer
http://www.aceflyer.com/
Fluid Mechanics, Leonard Euler – M. Cramer, Engineering Science and Mechanics, Virginia Tech
http://www.fluidmech.net/msc/euler.htm
Fluid Mechanics, Ludwig Prandtl – M. Cramer, Engineering Science and Mechanics, Virginia Tech
http://www.fluidmech.net/msc/prandtl.htm
Fluid Mechanics, Sir Isaac Newton – M. Cramer, Engineering Science and Mechanics, Virginia Tech
http://www.fluidmech.net/msc/newton.htm
Henry Darcy and His Law – Glenn Brown, Biosystems and Agricultural Engineering, Oklahoma State University
http://biosystems.okstate.edu/darcy/
Prandtl – Niall McMahon, Computer Applications, Dublin City University
http://student.dcu.ie/~mcmahon4/bioprandtl.html

History of Aviation and Aeronautics

Canada Aviation Museum
http://www.aviation.technomuses.ca/
Canadian Aviation Historical Society
http://www.cahs.com/
Canadian Warplane Heritage Museum
http://www.warplane.com/
Hiller Aviation Museum
http://www.hiller.org/
History of Aeronautics – Florida International University
http://www.allstar.fiu.edu/aero/#history
Kansas Cosmosphere and Space Center
http://www.cosmo.org/

NASA – National Aeronautics and Space Administration
http://www.nasa.gov/centers/langley/home/index.html
NASA History Office – National Aeronatuics and Space Administration
http://www.hq.nasa.gov/office/pao/History/
National Museum of Naval Aviation
http://naval.aviation.museum/intro.html
National Museum of the United States Airforce
http://www.wpafb.af.mil/museum/index.htm
Royal Airforce Museum
http://www.rafmuseum.org.uk/
Royal Canadian Air Force
http://www.rcaf.com/main.shtml
Seattle Museum of Flight
http://www.museumofflight.org/
Smithsonian National Air and Space Museum
http://www.nasm.si.edu/
Testing The First Supersonic Aircraft, NASA Facts Online – National Aeronautics and Space Administration
http://oea.larc.nasa.gov/PAIS/Supersonic.html
The History of Commercial Aviation – Sarah Ward
http://airlines.afriqonline.com/#
U.S. Centennial of Flight: Born of Dreams – Inspired by Freedom – U.S. Centennial of Flight Commission
http://www.centennialofflight.gov/index2.cfm
Virginia Aviation Museum
http://www.vam.smv.org/

History of Computational Fluid Dynamics

Historical Developments in Computational Fluid Dynamics – G. Biswas, Department of Mechanical Engineering, Indian Institute of Technology Kanpur
http://www.sali.freeservers.com/engineering/cfd/cfd_history.html

A challenge for educators is to either develop or find appropriate materials for use in their own classrooms. The aforementioned teaching resources, which include a fairly extensive listing of books and websites, offer a plethora of historic information, and should provide ample materials for instructors to use. Even though the authors have tried to be exhaustive, many more websites currently exist which are not listed here, and the reader is encouraged to explore the Internet for more.

CONCLUSIONS

Examining the historical background of fluid mechanics is very valuable to students, so that they understand that it is not just a static body of knowledge, theories, and equations that they have to learn in order to solve problems, so that they can pass their class and thus make progress toward earning their engineering degrees. Rather, it has a rich history that can trace its roots back to antiquity. In fact, its earliest applications were fundamental to the development of human

civilization itself. From that point onward throughout its history, applications and inventions developed through trial and error as well as mathematical theory have yielded many substantial results, including that of air transportation as well as space exploration, not to mention safe and sanitary drinking water supplies. As in the past, this discipline will continue to serve humanity, and many exciting applications are yet to be developed. Furthermore, ASEE is now actively pursuing its K-12 initiative and the history of engineering offers an excellent avenue to reach out to school children of all ages. This paper provides an insight that fluid mechanics and fluid power have been well served by a great number of scientists and engineers whose work could inspire an entirely new generation of engineers.

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BIOGRAPHICAL INFORMATION

KURT A ROSENTRATER is a Lead Scientist with the United States Department of Agriculture, Agriculture Research Service, in Brookings, SD, where he is spearheading a new initiative to develop value-added uses for residue streams resulting from biofuel manufacturing operations. He is formerly an assistant professor at Northern Illinois University, DeKalb, IL, in the Department of Technology.

RADHA BALAMURALIKRISHNA has an educational background in engineering, industrial education, and business administration. He is a licensed professional engineer in the State of Illinois. He received the Faculty of the Year award in 2000 sponsored by the College of Engineering and Engineering Technology. His primary areas of expertise are computer-aided design and process improvement methodologies.