Engineering & Physics Club
N E W S L E T T E R

SPRING 2004

"Do not go where the path may lead, go instead where there is no path and leave a trail"
-- Ralph Waldo Emerson

"Knowledge speaks, but wisdom listens"
-- Jimmy Hendrix

See the latest Puzzler -- page 3

Welcome to Our Spring Issue

Since our first issue, we've received a great deal of positive feedback and good suggestions, which we've incorporated here. For inclusion in future issues, send comments or original articles (engineering and physics related) to George Tootelian at gtoot1@comcast.net. To join the Engineering and Physics Club, contact John Kalinowski, club president, at Djkalinowski@aol.com.

Meet Our Executive Committee

Who are they, and what is the engineering connection?

E & P Club Officers, from left to right: John Kalinowski, President; Brian Witlin, Vice President; James Pierce. Treasurer; Begonia Hernandez, Secretary. ***See their bios, on page 3.***

Upcoming Events

Our next event is "Meet the Professional Engineers of the Northwest Chicago Region." It is scheduled for Wednesday, April 7, at 7:00 PM.

Engineers start out with an average salary of $49,000, with additional kickers for an M.S. degree and/or a P.E. license. Last year our attendance exceeded 50 prospective engineers and physicists, both men and women. You can hear first-hand, the road to a successful career in engineering. Sign up now! Contact Ms. Peggy Swedroe by phone (847-635-1688) or e-mail (pswedroe@oakton.edu).

Thus far, the club has visited Fermi Lab, Argonne National Labs, W.W. Grainger Automated Storage and Retrieval System, and Underwriters Laboratories. Don't be left out! Join the club and you can be included in our next tour.

We've also had three excellent talks on "Opportunities in Engineering and Physics," by Dean Joe Kotowski, and by engineers from UOP and Stanley Consultants.

Does Schooling Pay Off?

In our first issue we touched on a question Mr. Jerry Chernin posed to three different presenters on Opportunities in Engineering. His question: "How much of what you learned in school do you use in your present work?" The answer, from two of the three presenters, was "About 5 to 10%." The third presenter said she used all of the knowledge she gleaned from school. So who's right? From my experience, and that of my contemporaries, every contact you make contributes to your overall knowledge, your maturity and your value as a potential employee. Your experience at Oakton is invaluable because many of your professors and instructors have been employed in the industry or owned their own businesses. They pass on their experience to you, so you can eventually go out and become successful engineers, physicists, and teachers. – G. T.

"This disaster became one of the worst structural failures in United States history."

"Those who do not study the past are doomed to repeat it"
-- George Orwell

"No matter what else happens, this is the century in which we must learn to live without fossil fuels."

Great Engineering Disasters

The Kansas City Hyatt Regency Walkway Collapse

With a 40 story tower and a beautiful atrium, the Hyatt Regency was an impressive sight. It had opened after four years of design and construction. Even before completion, the atrium roof had collapsed due to lack of movement in the expansion joints and inadequate steel to steel connections. Because of the engineering concerns, the owner had hired another engineering company to reconfirm the roof design. This firm recalculated all connections and found nothing wrong.

Tragedy strikes

On the evening of July 17, 1981, about 2000 people gathered in the Hyatt, on the floor as well as on the suspended walkways, to watch a local radio station's dance competition. At 7:05 PM a sharp crack was heard. The second and fourth walkways crashed to the floor, killing 114 people, most instantly, and injuring 200, some seriously. This disaster became one of the worst structural failures in United States history.

Why did it happen?

The initial design required a strength of 412 MPa (60,000 P.S.I.) for the hanger rods of the suspended walkways. This was omitted for some inexplicable reason in the final drawings. The general notes allowed 248 MPa (36,000 P.S.I.). The original design was impractical, but not impossible, because it required the contractor to run nuts up 20 feet to the 4th floor box beam. The contractor modified the design using two hanger rods instead of one, placing them side-by-side in the box beams at the 4th level. The engineer approved the change without checking it out. This design doubled the load on the nut under the fourth floor. This nut now had to take the weight of two walkways instead of one. Even without this deadly modification, the connection would have supported only 60% of the 151,000 Newtons (34,000 lbs) required by the local code. With the modification, the connection could support only 30% of the minimum load. To help explain this, imagine a 180 lb person hanging from a rope suspended from the ceiling. Far below him is a second person, 180 lbs, hanging from the same rope. No problem so far. Now suppose the second person hangs onto the *legs* of the first person, essentially doubling the stress on the rope at this point of application. This is what happened when the design modification was allowed to go forward without any further checking.

What happened to the design engineers?

The Missouri Board of Architects, Professional Engineers and Land Surveyors convicted the engineer of record and the project engineer, of gross negligence, misconduct and unprofessional conduct. They both lost their licenses and membership in ASCE. The building had cost a large sum of money, but the damages awarded to the families of the victims made that sum paltry in comparison, as the awards ran into the billions of dollars.

Looking back

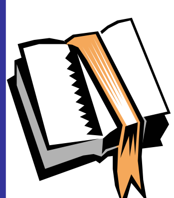
At the trial, the detailer, architect, fabricator and technician testified they had contacted the project engineer about the integrity of the connection details. Each time he assured them the connection was sound and that he had calculated its strength, when he really had not. He had shown a complete disregard for the public welfare.

Engineers must check and recheck their work to ensure the safety of the design, especially when life and limb are involved. Also in question was, what factor of safety was utilized, especially with regard to the consequences if the failure was to occur? It turned out to be less than one!

For additional information, see the following: Rachel Martin's report at www.eng.uab.edu/cee/reu_nsf99/hyatt.htm **,** *To Engineer is Human, the Role of Failure in Successful Design*, by Henry Petroski, and Newsweek's August 3, 1981; "What Happened at the Hyatt?"

NEXT NEWSLETTER: ***Galloping Gerty: The Tacoma Narrows Bridge Disaster***

Book Corner



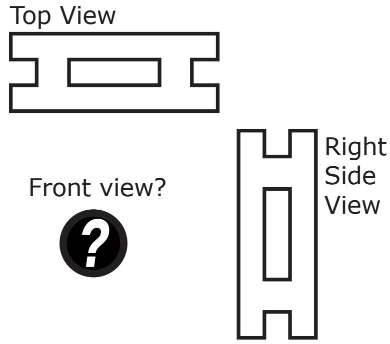
Out of Gas **by David Goldstein (W.W. Norton & Co., 2004)**

Geophysicist M. K. Hubbert had accurately predicted the decline of oil production in the U.S. back in the 1950s. Now Goldstein echoes that prediction and indicates the worldwide supply of oil will peak in as little as 10 years and decline after that. The author also clearly explains the mechanical, electrical, and atomic devices for harnessing and distributing power, from their earliest inceptions. Get your bicycles ready! Goldstein does offer solutions but states; "No matter what else happens, this is the century in which we must learn to live without fossil fuels."

Related books: *Hubbert's Peak: The Impending World Oil Shortage* by Kenneth S. Deffeves
The Party's Over: Oil, War and the Fate of Industrial Societies by Richard Heinberg

Note -- last issue's book picks are now available at the Oakton Library:
Ingenious Mechanisms for Designers and Inventors, by Franklin Day, Holbrook L. Horton
John Boyd: The Fighter Pilot who Changed the Art of War, by Robert Coram

This Month's Puzzler



This is an orthographic projection puzzle. The top and right side views are identical. There are no missing dotted or solid lines in the top or side views. Draw the front view.

Send your solution to the Engineering and Physics Club, room 1433, Des Plaines Campus. The winning answer will be selected by the executive committee and published in the next issue of the newsletter.

Solution to last month's Puzzler:

Remember the puzzler? A man wanted to paint the floor of his newly purchased merry–go-round with a very expensive, special-order epoxy paint. He asked his son to measure the outside and inside diameters of the merry-go-round floor so he could calculate the square footage. One quart would cover 250 square feet. The son came back with a measurement of 70 feet, equal to a straight line that was just tangent to the inner diameter, and convinced his dad that they could calculate it.

Here's how:

r = inside radius
R = outside radius
A = area to be painted

$r^2 + 35^2 = R^2$ (1) Pythagorean Theorem

$A = \pi (R^2 - r^2)$ (2) Area of large circle minus small circle

$A = \pi (r^2 + 35^2 - r^2)$ (3) Substitute (1) into (2)

$A = \pi \times 35^2 =$ 3846.5 feet^2 or 15.39 quarts of epoxy paint

Note: It didn't matter what the small radius was, did it?

Our Club Executives (continued from Page 1)

John Kalinowski, President John holds a certificate in Refrigeration from Harper College, which has helped him secure a job in refrigeration, a career he's enjoyed for the past 15 years. Advancements in technology and computerization make his job interesting and challenging. John's technical and problem solving skills are put to the test every day. John is focused and likes to find solutions quickly. In order to keep up with the daily challenges of his current career, and have prospects for further advancement, he's decided to pursue a college degree. So far, John has completed 20 credit hours and has many more to go. "It's a long road, but I'm fully committed to it." Away from school, John enjoys spending time with his family, fishing, boating and watching sports.

Brian Witlin, Vice President Brian's background is filled with an eclectic mix of everything *but* engineering. While an undergraduate at Lehigh University, Brian studied Marketing and Finance. He was senior class president and participated in the shaping of the future of Lehigh. There, Brian explored entrepreneurship and started two successful companies. After graduation, Brian studied classical art and design at renowned Barstone Studios, to pursue a passion for art and to prepare a portfolio for graduate school in product design (MS in Engineering). He chose Oakton as a perfect fit to complete all engineering prerequisites needed for acceptance. Brian hopes to attend Stanford University and is waiting for a letter of acceptance. The Engineering and Physics Club wishes Brian the best of luck in his future art and engineering goals.

James Pierce, Treasurer James is currently seeking a certificate in manufacturing and machine tool technology from Triton College. He is also interested in machine design and mechanical engineering. Jimmy finished high school in the top 1% of his class and decided to attend Oakton and Triton. James enjoys camping and received his Eagle Scout rank from Troop 1 of Park Ridge, the oldest chartered troop in America. An active musician, James plays bass in the rhythm and blues band, "Ass Can." Recently, he ran and completed the 2003 Chicago Marathon. His TV show, "Barely Sober" is scheduled to air on public access channel 35 sometime this year. James encourages all members of the Engineering and Physics Club to "make this the best year for the club!"

Begonia Hernandez, Secretary Club Secretary, Begonia Hernandez has an interesting international background. She studied mechanical drafting after high school in Spain. At a relatively young age, Begonia put her skills to use as a consultant with McDonalds Corporation. She soon became interested in the engineering side of the business, and went back to school to pursue a degree in engineering. Begonia states; "The classes, faculty, staff, and students at Oakton are great. I'm amazed at how interesting my classes are, and although it can be very challenging at times, I'm having lots of fun, meeting interesting people and feeling confident in knowing that my education at Oakton will serve me well for the rest of my life."

"Do, or do not. There is no 'try'."
--Yoda (The Empire Strikes Back)

A Brief History of Aerodynamics - *Part I*

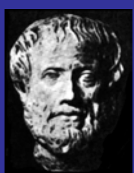
By James Cooper

The Kitty Hawk Centennial Flight highlighted a milestone in the history of aviation. Like many early pioneers of flight, the Wright Brothers were amateur engineers and empiricists, practical men who were not formally schooled in the theoretical sciences. Nonetheless, they did rely heavily on established aeronautical knowledge to design their aircraft. In this series of articles we explore the history of aerodynamics; the advances in theoretical knowledge that contributed to the success of manned fight at the dawn of the 20th century.

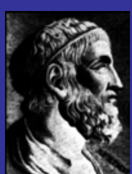
The first contributions to the science of aerodynamics were made during the 3rd and 4th centuries, B.C.

The Beginnings of Aerodynamics

Observations of the flight of birds and projectiles stirred speculation among the ancients as to the forces involved and the manner of their interaction. They, however, had no concrete knowledge of the properties of air, nor any systematic method for the study of those properties. Science as it was known then was still largely a matter of pure intellectual speculation and the concept of experiment as the test of scientific validity was centuries away from being adopted. Yet the first noteworthy contributions to the science of aerodynamics were made by Aristotle and Archimedes during the 4th and 3rd centuries B.C. and by Leonardo da Vinci during the Renaissance in the late 15th and early 16th centuries.



Aristotle



Archimedes

The most important scientist during the golden age of Greek culture was Aristotle (384-322 B.C.). He was a man of prodigious intellect who developed a corpus of philosophy, science, ethics and law that has influenced the world to this day. In direct contrast to the philosophy of Plato (Aristotle's own tutor), Aristotelian science was empirical in nature, based on observation and not so concerned with the 'whys' of the physical world but rather on results and consequences of various phenomena. Of all Aristotle's scientific ideas, two are particularly important in the history of aerodynamics. The first is the concept of a *continuum.* He wrote that "the continuous may be defined as that which is divisible into parts which are themselves divisible into infinity, as a body which is divisible in all ways. Magnitude divisible in one direction is a line, in three directions a body. And magnitudes which are divisible in this fashion are continuous." (Aristotle, *Treatise on the Heavens,* Book I). The importance of this concept is such that the continuum flow model is used to represent airflow in 99% of all aerodynamic applications today.

Aristotle's second contribution to aerodynamics was his idea that an object moving through air or another fluid encountered some form of "resistance". While he incorrectly reasoned that a body in motion required a constant application of force to keep it moving, his thoughts were heading in the right direction regarding motion in a vacuum. He wrote that "it is impossible to say why a body that has been set in motion in a vacuum should ever come to rest. Why, indeed, should it come to rest at one place over another? As a consequence, it will either necessarily stay at rest, or if in motion, will move indefinitely unless some obstacle comes in collision with it" (*Treatise on the Heavens,* Book I). A conclusion that follows from this reasoning is that because a moving object will eventually come to rest in a fluid, there must be a resistance acting on it. In aerodynamics today, this force is known as the aerodynamic *drag*.

Approximately one century later, advances were made in the study of fluids by the prominent mathematician and engineer Archimedes (287-212 B.C.). In the employ of Heiron II, the king of Syracuse, Archimedes devised numerous engineering inventions, including the Archimedean screw which lifts water to higher elevations and the development of the mechanical lever. However, it is Archimedes' development of the mechanical principles of fluids at rest, or fluid statics, that ensure his place in the history of aerodynamics.

First, he clearly stated that a fluid (gas or liquid) is a continuous substance and can be treated mathematically as a continuum and he went on to apply the continuum concept first stated by Aristotle a century earlier. Second, Archimedes had some understanding of pressure. He realized that a surface immersed in a fluid was subjected to a force due to the fluid, and wrote that "each part is always pressed by the whole weight of the column perpendicularly above it." This was the first statement of a fluid statics principle which states that the pressure at a point in a stationary fluid is due to the weight of the fluid above it and hence is linearly proportional to the depth of the fluid. Pilots, of course, will be familiar with this concept as it relates to density altitude. Third, Archimedes also understood that stagnant fluid was set into motion by a change in pressure. He wrote that "if fluid parts are continuous and uniformly distributed, then that of them which is least compressed is driven along by that which is more compressed." We now call this a pressure gradient, which is the measure of pressure difference over a unit length.

From the time of Aristotle's death in 212 B.C., more than seventeen centuries elapsed before the next significant contribution was made to the science of aerodynamics. The state of aerodynamics inherited by Renaissance genius Leonardo da Vinci was fragmented and totally immature, yet he developed aerodynamic concepts that were amazingly advanced for his time. And as the first person who also gave serious thought to the design of flying machines, it is Leonardo da Vinci whom we will discuss in our next article.

James Cooper is a former arts and entertainment marketer from Australia who is planning a new career in aerospace engineering. He will start engineering prerequisites at Oakton in the Fall to resume studies that he began in 1989 at RMIT University in Melbourne. Currently he is an active member of the Experimental Aircraft Association (EAA) and is restoring a Taylorcraft airplane with members of EAA Chapter 790 (Barrington, IL). This is his first of a series of articles for the EAA and our club, exploring the history of aerodynamics.

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