The Ohio State
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From The Editor

Getting Real: A Reality Show that Teaches

A simple hand gesture and a simple phrase hooked me in—you're fired. I have finally fallen into the reality show craze. I can honestly say that I never thought I would religiously watch a show, let alone a reality show. Maybe it was fighting for a high profile job instead of a tanned buxom beauty or a wad of cash that intrigued this weary engineering student. Maybe it was just The Donald. I often rolled my eyes at my female friends whom you would think would give up their firstborns to see the next episode of The Bachelor. However, I am the one patiently anticipating a reality show every Thursday night. The Apprentice has reeled me in, and I have no means of escaping. However, unlike many reality television shows, NBC's latest reality contest can actually benefit the couch potato watching at home.

In each episode, two teams of driven individuals partake in a contest for billionaire mogul, Donald Trump. These tasks assess the sales, management, negotiation, and marketing skills of each player, while also forcing them to work as a cohesive team to win the task. Each team appoints a Project Manager that will lead the group, often taking the blame for a failure or the basking in the glory for a triumph. The jobs include selling lemonade, renovating and renting an apartment, negotiating prices of merchandise, and managing a restaurant. I know what you are thinking. "I'm an engineer, and I don't plan on working in sales or management." Well, hold on there my pocket-protector-wearing comrade, but the skills and ideas that The Apprentice will help you in wherever you are going to work, whether the boardroom, the test floor, or the lab.

Every episode is themed in a different manner, with The Donald voicing his definition of each theme. This central idea usually is the reason the next cast member is fired from the show. For example, a recent episode was themed, "You must think outside the box." The objective was to earn money by running a pedicab service in New York City. The winning team sold advertisements on each pedicab while the other team focused on earning their money solely through rides fares. As an engineer, you must often think creatively outside the norm when you are researching, experimenting, or debugging in order to achieve the goal. That is really how inventions are born and patents are created.

Other important characteristics in successful people are also highlighted on the show. Cast members have bickered with one another about integrity, work ethic, and negotiation skills. Engineers have to negotiate their salaries, who can use what equipment when, etc., while working hard with integrity. Teamwork is essential for the success of any corporation and internal strife can be devastating to productivity. On this show, your degree or degrees are metaphorically thrown out the window as people with MBAs, medical doctorates, and engineering degrees have been fired because they did not have the characteristics it takes to be a President of a Trump-owned company. Actually, the only person with an engineering background on the show was fired by The Donald because she did not stick up for herself when she was the project manager on a losing team.

Not only do I feel the show can be beneficial, but so do others. Eugene Muscat, a senior associate dean of the University of San Francisco's School of Business and Management stated, "I think Donald Trump might be giving some feedback that just might be valuable," in a recent interview in The Kansas City Star. Watching this reality show may help you improve your skills in the workplace, and maybe, one day you'll find an ambitious young Ohio State electrical engineering graduate on The Apprentice 2.

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SAVING THE HERITAGE: COLUMBUS, OHIO

By: Parag Agarwal

"Therefore, when we build, let us think we build forever............let us think, as we lay stone on stone, that a time is to come when those stones will be held sacred because our hands have touched them."
John Ruskin.

Historic resources are vital elements of our Nation's cultural gamut and they contribute significantly to the society and to individual's identity. Let's face it: the word 'Historic Preservation' is convoluted and encompasses an array of different subjects, but most people relate 'historic' with 'age' and for them 'Historic Preservation' deals with protection of 'old' or 'ancient' buildings. 'Old' or 'ancient' are again the relative words, which may depict different time frames for different cultures. Romans, pioneers of civilization will call St. Peter's of Rome at Vatican City built in mid 16th century as historic, while in the United States we even classify Pennsylvania Station in New York built in 1910 as a celebrated structure. When you cut through all the slang and rhetoric, Historic Preservation is simply saving any structure or neighborhood that is significant to the nation and to the society.

Many say that the concept of 'preservation' is simply against the American psyche and traditions, who are considered to be the world's principal consumers. American's have always favored 'change', 'growth' and 'development', the words which are visualized to be contradictory to the fundamentals "preservation'. However, the interest in Historic Preservation arose in the twentieth century when our society grew mature and the focus shifted from quantitative to qualitative aspects of development, which led to the interest in preserving the quality built environment.

Columbus, the state capital of Ohio and most importantly the home of Buckeyes, has been long known for its fine buildings and historic neighborhoods. Columbus architectural heritage includes the German Village, largest privately funded Historic District on the National Register of Historic Places, and the State Capitol building built in 1861. However, over the last few decades the city has been sculpted by its own growth. Due to the different actions of public and private sectors, historical properties have a way of disappearing. They quietly fall prey to demolition, or renovations, the most notable amongst them was the razing of Union Station in 1976 to make way for temporary parking related to the Nationwide Arena construction project. To prevent the blunders of historic magnitude, the preservation movement started in the city in 1960 with the formation of the German Village Society to rejuvenate the south end of Columbus now known as the German Village. Although a more formal beginning took place about three years later when the city got its first Historic District: German Village, in 1963, three decades after the formation of first historic district of United States in Charleston, South Carolina.

Since then, numerous organizations like Columbus Landmarks Foundations, Ohio Historical Society, Ohio Preservation Alliance have been formed through community initiatives to safeguard the city's heritage.

The historic character of Columbus neighborhoods is maintained by five architectural review commissions whose primary function is to review any structural alterations or new developments that take place in their jurisdictions. The four village architectural commissions (German Village, Victorian Village, Italian Village and the Brewery Village) help in preserving the character of the city's four historic neighborhoods. The fifth commission: Historical Resource Commission (HRC) was created to protect the character of the buildings and neighborhoods listed in the Columbus Register of Historic Properties, which is City's official listing of buildings, sites and districts of architectural and historical significance. There are currently nineteen designated Historic Districts and forty two properties individually listed in the Columbus Register of Historic Properties, with the first being registered in 1982. To be eligible for the listing in the Columbus register, all individual properties must be typically over 40 years old and their nominations are strictly done on the voluntary basis. Although listing of the properties in the Columbus Register does not guarantee any tax incentives or state or city funding, the property owners have other benefits like the historic designation reinforces the architectural importance of the building and provides protection to the neighborhood from incompatible changes.

The proposed establishment of Historic Districts, covered by ordinance, has often been met with opposition with a variety of concerns. It is very important to address these misgivings when promoting the concept of Historic Preservation. The following are some of the primary misconceptions which the people have, related to preservation movement:

Housing character, adds to the historic fiber of the German Village

Misconception: Preservation is only for high-style buildings associated with famous, dead, and rich people.

Truth: As stated in the introductory statements, preservation deals with all built environments that are significant to the nation. Many of the properties listed in the Columbus Register were built by working class or middle class families such as many properties in Historic Districts of Italian and Victorian Villages. The Register has a broad spectrum of properties ranging from government subsidized housing, schools, cathedrals, post offices and the courthouses.

Misconception: Although the society benefits from the Historic Districts, the residents are unsatisfied due to the various limitations imposed on them.

Truth: As expected Historic Districts may be opposed by private individuals who assert their rights with a cry “Why am I being told what I can and can't do with my own property”? This attitude runs deep in American consciousness. This is perhaps the most misunderstood concern as most architectural reviews allows for alterations provided they do not damage the historic character of streetscape. Moreover the residents buy the properties in the Historic Districts with full knowledge of the architectural review guidelines and hence are expected comply to with them.

Misconception: An architectural review leads to reduction in the property values

Truth: On the contrary, properties in the Historic Districts are worth more, appreciate faster, and retain more of their value than properties located outside the Historic Districts. In fact, Historic District status and its architectural review have made German Village the most desirable neighborhood in Columbus although it was once the best example of 20th century urban decline till 1950s. To analyze the real estate market activity in Columbus, the study was conducted by German Village Commission in 1999. As per the study, auditors assessed value of properties in German Village and in Columbus for the years 1963 and 1999. The result depicts that the property values appreciated by approximately 100% in the City of Columbus as compared to 478% in German Village in the given time frame.

Aesthetics, environmental, educational, social, and psychological reasons – all justify the concept of Historic Preservation. Few realize that through Historic Preservation, communities can create new

Brick paved streets adds to the pedestrian friendly character of the Historic neighborhoods

jobs as rehabilitation and the conservation projects are highly labor intensive. Due to different initiatives taken by public and private sector, our society has realized that Historic Preservation is about keeping the best of the old in relation with new development.

The Ohio State ENGINEER

Superconductivity

By: Dan Huynh

Introduction

Since its discovery in 1911, superconductivity has been greatly discussed in the world of physics. Superconductivity baffled the great minds of physics for years until 1957 when John Bardeen, Leon Cooper, and Robert Schrieffer won a Nobel Prize for their theory on superconductivity, known as the BCS theory. Since then, superconductors have been used for a variety of applications, especially in regards to surface and interface science. Superconductors have been used in many different ways including, most notably, magnetic resonance imaging (MRI). In addition, superconductivity surface and interface science has been vastly researched in the past few decades, and has led to innovative discoveries regarding the fabrication of superconductive thin films, the use of superconductor-insulator-superconductor junctions (Josephson junctions), and even magnetic field imaging of material surfaces through Scanning SQUID Microscopy.

Fundamentals of Superconductivity

Ideally, superconductors are materials that can conduct electricity without a loss in energy. There is no loss in energy because the superconductive material has very minimal resistance, or ideally, zero resistance. In a normal metal, valence electrons become delocalized in the conduction band and roam around the lattice. As an electric field is applied, electron velocity increases, but the electrons collide with one another and scatter. Because of this fact, there is a maximum velocity the electron can reach. The amount of electron scattering determines the material's resistance. As temperature increases, so does electron scattering, hence the increase in resistance. The resistance creates heat, and sometimes, light. When this process occurs, energy is loss in the system.

On the other hand, superconductors have no scattering because superconducting electrons do not collide with anything. There is no loss in energy or current because the electrons travel through the complex lattice of the superconductive material unhindered. One would imagine that since the rise in temperature correlates to the rise in resistivity, all that would need to be done is to decrease the temperature of the material. This idea is a simple thought involved in a much more complex theory.

Theorized by Bardeen, Cooper, and Schrieffer, the BCS theory explains superconductivity when temperature begins to decrease toward absolute zero. The unification of current flow is due to atomic lattice vibrations. Pairs of electrons, called Cooper pairs, are formed in superconductors in order to maneuver around obstacles that may cause scattering. Two electrons would normally want to repel each other according to the laws of physics. However, as an electron passes close to an ion in the lattice, an attraction between the negative electron and positive ion causes vibrations that are passed from ion to ion until it reaches another electron. This electron then absorbs the vibration. Therefore, the first electron emits a phonon and the second electron mentioned absorbs a photon. The force exerted by the phonons dominates the electrons' repulsion, and thus, a Cooper pair is formed.

However, it should be noted that Cooper pairs break apart and reform constantly and are by no means permanent. The colder the temperature is, the longer these pairs stay together. If a superconductor gains heat, the lattice vibrations will break these Cooper pairs and force the material to lose its superconductivity. The temperature that defines the

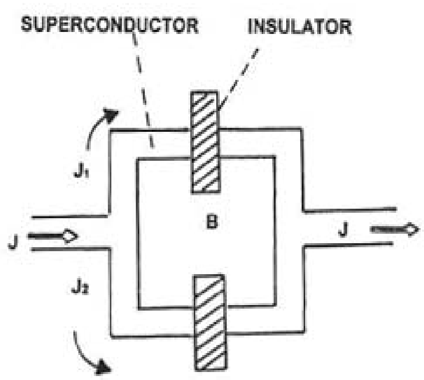

Figure 1: Schematic of a SQUID23

boundary for conductivity and superconductivity is called the critical temperature (Tc). The lower the temperature is from Tc, the more superconductive the material.

In the world of superconductivity, the higher the critical temperature is, the better it is for researchers since they have a larger temperature window to keep that material superconductive. In addition, if a current is applied to the material, a magnetic field (H) is created around it. Since superconductors do not have a loss of energy or current, this magnetic field is even greater for these types of materials. Similar to temperature, there is a magnetic field that defines the boundary for conductivity and superconductivity called the critical magnetic field (Hc).

Antoher important factor of superconductors is critical current density (Jc). The critical current density is another boundary point between conductivity and superconductivity. All three of the critical values (Tc, Hc, & Jc) work very close together.

Josephson Junctions

Another important aspect of superconductive materials is their use at interfaces. For example, Josephson junctions are used when interfacing two superconductors together with a thin barrier in between them.

Two different types of Josephson effects can take place—an AC and a DC version. The AC Josephson effect involves the characteristic frequency oscillation of a Josephson junction being proportional to the voltage across its junction. Because of this feature, Josephson junctions are used as a standard measure of voltage. In the AC Josephson effect, a voltage is applied to the junction, but with no magnetic fields applied.

The DC Josephson effect involves applying a current instead of a voltage to the junction until the critical current is reached. The Cooper pairs tunneling through the barrier from one superconductor to the other have a similar wave function to that of a free particle. Also, in order for the junction to work properly, all the Cooper pairs must be phase coherent, meaning that they all have the same phase. Once the critical current is reached, single electron tunneling dominates the Cooper pairs. By placing an insulating layer in between the superconductors, Cooper pairs can travel through the insulating barrier without any resistance. This insulating layer is usually around 10-20 angstroms thick, and has to be smaller than the coherence length. The coherence length is the maximum length the junction can be before it loses its superconductive effect.

An interesting application to Josephson junctions is to position a wire adjacent to the junction and apply a current to it. The magnetic field created by the wire will actually lower the critical current of the Josephson junction. By using these principles, one can use a Josephson junction as a switching device that switches at ultrahigh speeds. Actually, the switching speeds of Josephson junctions have been measured at ten times faster than traditional semiconductor switches. Because of this fact, researchers have been working to use Josephson junctions in computers to improve speeds since computer speed relies directly on the time needed to transmit signal pulses. Actually, IBM tried to perfect this theory by attempting to use Josephson junctions to build a computer. However, they had difficulties when some of the computer's circuitry housed stray magnetic fields that affected the mechanics of the Josephson junctions. This quandary serendipitously led to the invention of the scanning SQUID microscope that has been used to image magnetic fields at material surfaces.

Superconducting Quantum Interference Devices (SQUIDs)

A SQUID is a highly sensitive magnetic field detector. Being ultra sensitive to magnetic flux, a SQUID can measure magnetic fields of around 2 pT, and some have been recorded measuring fields of about 100 fT.

SQUIDs can even measure magnetic fields hundred of billions smaller than the earth's magnetic field. SQUIDs are basically superconductive loops that have two "weak link" Josephson junctions in them.

These two localized areas of the loop where the Josephson junctions are positioned are where the critical currents are abruptly reduced. By applying a current above the critical current, SQUIDs become operational.

SQUIDs have been used for a variety of applications such as magnetometers, gradiometers, DC comparators, noise thermometry, biomagnetism, and brain imaging. However, in regards to surface and interface science, SQUID technology has opened the door for a new type of imaging of surfaces—scanning SQUID microscopy (SSM).

Scanning SQUID Microscopy

Since SQUIDs are the most sensitive to magnetic fields, applying SQUID technology to the imaging industry has fostered great understanding of magnetic fields at the surfaces of materials

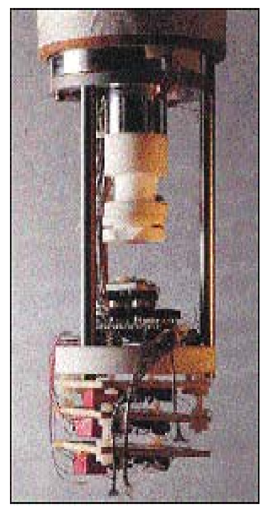

Figure 2: Visual Representation of a Typical Scanning SQUID Microscope

and elements. The use of SQUIDs to image magnetic fields at surfaces of materials is called Scanning SQUID Microscopy. As discussed earlier, SSM was produced to solve problems with trapped magnetic fields in prototype Josephson junction-based computers. IBM Co-op student F. Patrick Rogers designed the first SSM under the supervision of Stuart Bermon at the IBM Thomas J. Watson Research Center. The SSM was built as a diagnostic tool for determining where magnetic flux was trapped. The basic design was made from a pickup loop connecting to a point-contact RF SQUID, beveled gears, driving rods, and DC motors. The sample was then scanned past the pickup loop several times, revealing individual flux vortices in the niobium through line-scan images. The spatial resolution was at a weak 500 µm and a signal-to-noise ratio of around 5 however.

Since the first prototype of SSM, the experimental setup has changed in order to improve magnetic imaging that can reach a spatial resolution of 4 µm and a better signal-to-noise ratio of 1000. By hanging the entire SSM from the ceiling, vibrations are reduced significantly and no external noise affects the system. Moreover, the SQUIDs used in SSM are fabricated from niobium with thin film, aluminum oxide Josephson junctions.

In more recent versions of SSM, the SQUID is actually held stationary due to its sensitivity to external magnetic fields and field gradients. Because of this fact, the sample is moved in a scanning fashion using a piezoelectric scanning instrument. Scanning is quite important to SSM success because the motor speed of SSM actually limits the scan time. However some believe the SQUID response time is the limiting factor.

Scanning SQUID Microscopy is so sensitive to magnetic fields that almost everything on the material's surface appears to be magnetic—sensing magnetic moments at a few hundred Bohr magnetons, currents in nanoamperes, and fields smaller than a hundred picoteslas. SSM is capable of being sensitive enough to work in the dc to 400 gigahertz frequency range while also being able to image spatial resolutions to 4 µm. Amazingly, SSM can even detects hidden wiring and defect that are imbedded in the surface. The magnetic fields of the material are imaged through a computer by forming false color images. These images are that of weak magnetic fields of the sample.

Many other benefits of SSM have been seen since the beginning of this unique technology. One important benefit of SSM is that it provides a method to magnetically image without damaging the sample. Also, there is a low required current to operate the SSM, while being able to image the sample from both front and back. Most recently, SSM samples do not need preparation and can be imaged at room temperature in air as opposed to the classical method at cryogenic temperatures.

Although SSM has many benefits and pros in the magnetic imaging industry, there have been some problems. First and foremost, the spatial resolution is quite poor compared to Scanning Electron Microscopy with Polarisation Analysis (SEMPA). SSM has a spatial resolution at best 1 µm, whereas SEMPA can reach 30-50 nm. Similarly, Lorentz microscopes can also achieve greater spatial resolution. By creating a pick-up loop with the diameter that is roughly the distance from loop to sample, the best balance between spatial resolution and sensitivity can be achieved. Actually, at the Stanford Nanofabrication Facility, engineers are researching to develop pick-up loops that have a diameter of half a micron to a micron. By doing so, they hope to increase SSM sensitivity and spatial resolution. Unfortunately, thus far, they have not been able to make a niobium and silicon dioxide SSM pick-up loop due to problems with alignment during etching.

Equally important, in the past, SSM needed a cryogenic atmosphere that was a definite drawback by providing a restriction on the environment. However, research at the University of

Maryland states that using SSM on a room temperature sample can be performed with success. Research is still being performed in regards to temperature and the effectiveness of SSM.

Although there are some issues and problems, mainly with spatial resolution issues, many applications for SSM use can be seen. SSM can detect power-to-ground shorts, along with logic shorts. Also, design verification can be performed and determine package and chip leakage.

SSM has been used to image unexpected vortices that may appear in circuitry and thin films. This application is the reason SSM was invented—to find vortices. Vortices encompass magnetic field lines that are trapped inside circuitry or a thin film due to external magnetic fields. By using SSM, studies have been made to deal with this problem. SSM can image where these vortices are on the material, as well as imaging the means to dea with these problems. By setting up trapping sites—holes or moats—magnetic fields become trapped in these areas instead of important circuitry. Imaging of these holes and moats has been performed by SSM to verify that this theory holds true. SSM has proven that moats seem more effective than holes in regards to trapping these vortices.

Likewise, the use of SSM to find magnetic flux has been a useful application to surface science. In order to prove this fact, an experiment was set up making four rings using a photolithographic process on bicrystal substrates. A YBCO thin film was deposited via laser onto the surface. The middle ring had magnetic flux thread imbedded in it while the others did not. The middle ring image is much taller and provides several colors, depending on the magnetism present in the ring, while the other ones did not have magnetic flux imbedded in them.

Currently, SSM has even been used in the study of corrosion on metal surfaces. This study includes the analysis of aircraft lap joints and possible hidden corrosion. The reason SSM is well suited for this task is that it can map currents within the sample without actually touching the surface. This way, the sample is not damaged and accurate results can be obtained.

Conclusion

In conclusion, superconductive materials have made a great impact with their applications in surface and interface science. Having minimal to zero resistance, superconductive materials, such as YBCO, havebeen used in a wide variety of applications including Josephson junctions and Scanning SQUID Microscopy.

Surface and interface science researchers have greatly welcomed superconductive technology. From superconductive interfaces, to the imaging of magnetic fields, superconductive surface and interface science has greatly helped many industries in the world and should foster more advances in technology in years to come.

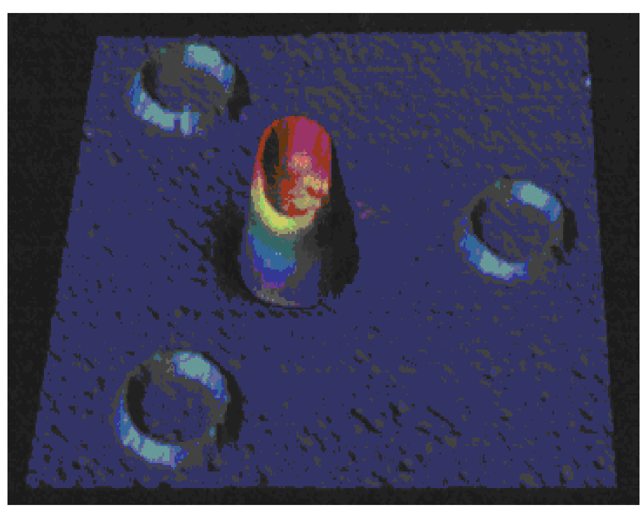

Figure 3: SSM Image of Fabricated Rings20

“The World is changing” is a constant.

By: Satya Thakkar

Every week we might find at least a small leap of advancement in our lives. Most of these changes are the result of some engineer’s hard work, but whatever it may; it helps this world grow more beautiful and easy to handle in general.

One of the latest advances that might change our lives in the coming decade or so is Light Emitting Polymers (LEP). LEP is a technology based on the use of polymer as the semiconductor material in Light Emitting Diodes. Polymers are chemical substances that consist of large molecules that are, themselves, made from many smaller and simpler molecules: proteins and DNA are examples of naturally occurring polymers.

Applications of LEP may be as diverse as changing the colors of your bedroom walls at a click, providing electronically news on something called e-paper (different from the news on the websites), television screens so thin they can be rolled up and stored in a living room corner, and video displays small enough for use on a cellular phone and much more.

In 1989, LEPs were first discovered by R. Friend and his colleagues at Cavendish Laboratory, Cambridge University (Holton, 1997). The team found yellow-green light emitted from poly p-phenylene vinylene, (PPV), when subjected to an electric field (Burroughnes et al., 1990). But the polymers studied there were very unstable when exposed to oxygen and required a high-level of voltage to function. A team of researchers at The Ohio State University has discovered new LEPs that do not degrade in the presence of oxygen and can operate on the amount of electricity produced by two AA batteries.

LEPs belong to a special class of polymers called ‘conjugated’ polymers. These polymers posess delocalized pi-electrons along the backbone. In the sense of mobility of delocalized pi-electrons, LEPs show the potential of semiconductors. Unlike LCDs, LEPs have no restrictions on viewing angles and do not require backlight and color filters. LEPs also can achieve an efficiency of 5% which is comparable to conventional LEDs at low voltages, but provide higher contrast and faster switching speed. In addition, the patterning process of LEPs is simple due to only one transparent substrate, coated with polymer layers, is required. Therefore, thin, conformable display screens become possible, using flexible plastic substrates.

Like ink a solution of a LEP can be used to easily "paint" an electrical light source onto an appropriate substrate. By engineering the chemical structure of the LEP all emission colors can be obtained. Because plastic materials are flexible and robust even non-planar displays can be manufactured.

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The History of the Lego

By: Curt Mrowiec

Over the past 70 years the "Automatic Binding Brick" has endured many changes and obstacles including two World Wars and one new name, the Lego, to become one of the most popular toys in the world. Presently, there are 52 Legos per person in the world. In fact, the Lego name has become so recognizable that it was added to the Oxford English Dictionary in 1990. The Automatic Binding Brick was initially designed by Ole Kirk Christiansen, a master carpenter, in 1930 in small town in rural Denmark. Previously, Christiansen's shop produced step ladders, ironing boards, and wooden toys. The master carpenter's new creation – the binding brick, was a flop in stores and Christiansen refocused his efforts on his previous ventures. It was not until 1947 when Christiansen purchased an injection molding machine did modern Legos began to take the form with which people today are familiar. Christiansen was the first to use an injecting molding machine for the purpose of making toys. A year later, a sailor, was introduced as the first Lego man.

In 1950 a horrible fire swept through the Christiansen factory, destroying all the company's assets. It was at this time that Ole Kirk Christiansen decided to change the focus of his company. The name of his "Automatic Binding Brick" was changed to Lego. This also was to become the name of his company. In the resulting years, the Lego began to explode onto the world stage. In large part, this was due to Christiansen's unwavering desire for quality in Lego's production. Today, this unwavering quest for quality continues. The tolerances for a Lego are within 1/1000 of a millimeter. This insures that every individual piece will fit perfectly into any other piece. Christiansen has stood by his word that "Only the best is good enough." The name Lego, in fact, means "to play well" in Danish.

Today, Legos can be found in almost every country throughout the world. Legos are no longer limited to the simple six stud bricks of their beginnings. Now Legos come in hundreds of varying shapes. There are even motorized and robotic Legos. There are currently over 1,964 unique shaped bricks. Legos have become so popular that there are amusement parks devoted strictly to them. Lego Land in California is home to many of the world's largest Lego displays. In fact, the largest Lego display in the world, the Technosaurus contains over one million individual Lego pieces, is located in Lego Land.

The Lego company is still privately owned by the Christiansen family, and today they employ thousands of people in Denmark, the United States, and the throughout the world. This is a far cry from their original ten employees in 1930. Today, the Lego Company is worth in excess of two billion dollars. Throughout the world children and adults alike spend more than 5 billion hours playing with Legos. The Lego has come a long way since its inception in the small 10 employee shop in Billund, Denmark.

Defining Paris Engineering

By: L. E. Smith

Imagine Paris. Now imagine Paris without the Eiffel Tower, without its boulevards - before its grand existence as the City of Light. Examining the historical physical growth of the city gives us a good idea of why Paris is the way it is today with its beautiful apartment buildings, large boulevards, Paris Canal, and of course the Eiffel Tower. These engineering masterpieces have set this city apart from others as well as provided necessary functions within it. A careful look reveals the significance of each to the overall design of the city.

Paris began on the Île de la Cité in the 3rd century BC; it was founded by Celtic Gaules. Originating on the island in the middle of the Seine, the city grew first to the left bank of the river Seine then across to the right bank. As the city became an important trading center, it also suffered many invasions, all which left their own distinguishing characteristics on the city. In 585 BC, the invaders were the Romans who conquered the city; the population at this time was 6,000. One can still find ancient Roman baths in parts of the left bank today. In 481 AD, the Franks attacked and took control.

For 600 years the city continued to grow outward until King Philip Augustus in the 13th century built a castle and wall around the city for protection; the Louvre is part of the original walled city, which at one time defined Paris by enclosing it into 600 acres. The wall had a watch tower every 50 yards including the largest, the Great Tower which stood at 100 feet tall with a 150 foot circumference. It was a double barrier, one wall then an expanse that extended approximate 10 feet to another wall all the way around

Paris Wall inside the Louvre

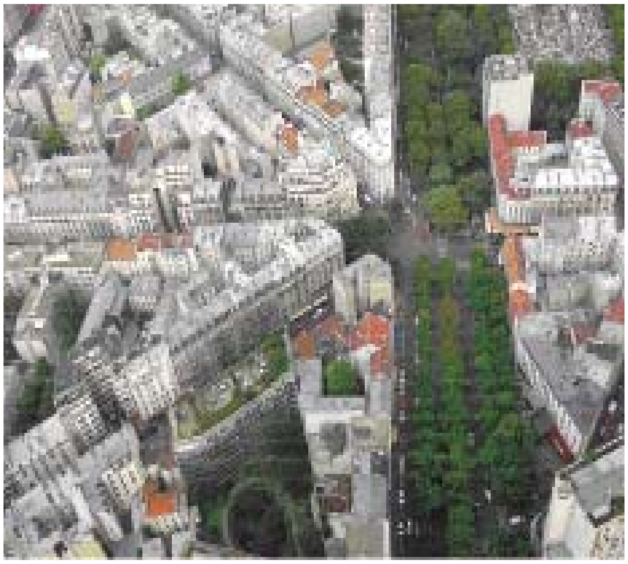
the city. This protected the inhabitants and the king from both invaders from the West and possible usurping subjects to the East. This walled city became a model for other cities in search of protection from aggressors; an example can be seen in Vienna, Austria. The outward growth stopped but inside the city walls, the population continued to grow, eventually to 250,000 by 1328. You can still find parts of the original wall around the city and in the foundations of the Louvre, where this photograph was taken.

Population increases necessitated the building of the Paris canal, another engineering masterpiece. Aqueducts had been built under the city to draw water from the Seine, but they were not enough. Water was rationed to 2 pints per person, due to the intense shortage. King Louis XIV had vacated the city and created Versailles as the new capital to

Paris Canal

escape the problems contained within the city. After the Revolution, plague and lack of water forced a solution. Ordered by Napoleon and engineered by Pierre-Simon Girard, the Paris Canal stretches from 60 miles outside the city to the Seine through the 10th Arrondissement. The water is drawn by pumping stations still in use today, built and designed by Girard; the canal prove to be a difficult engineering design as it is at height of 30 feet above the elevation of the river from which it is drawn. Fountains were also built at this time not only for beauty, but as a way to provide water to the people. Today the canal is still in service but has the added feature of attracting tourists to take a leisurely cruise down it.

The next engineering feat was contributed by



Haussmann's grand boulevards

Baron Georges-Eugene Haussmann, who began one of the largest urban renewal projects ever completed; it changed and influenced the social as well as psychological redevelopment of city landscape. After the French Revolution the city was in shambles, unemployment, and mass poverty affected most inhabitants. Narrow streets and aging sewer systems reflected a dismal existence for most Parisians. In a massive effort to employ the population and rebuild the image of Paris, Napoleon III appointed Haussmann prefect and directed him to incorporate the Paris suburbs; this increased the population by 400,000 as well as doubling the land attributed to the city. His urban design plan was to open up the old center of the city by improving transportation and circulation, bring green space into the city and combine state interests with private interests in development. Haussmann united his wide boulevard design while maintaining some of the smaller streets and erected large apartment buildings with the ground floor commercial space and upstairs residential housing units. This helped sustain the density of the city while maintaining community and neighborhood qualities of distinct areas, according to Michael Carmona, author of Haussmannn: his life and times, and the making of modern Paris. The dual nature of the design opened the city, as well as provided access throughout. He kept in mind that another revolution was possible and this design prevented portions of the city from being sectioned off by revolutionaries while continuing to nurture Paris neighborhoods and communities. The city's rooftops and wide boulevards can be seen in this picture taken from atop Montparnasse, the city's only skyscraper. The city has only the one skyscraper due to the aqueducts and excavation of limestone resulting in an unstable underground physical geography of the city.

Gustave Eiffel's construction at the time, one of the world's largest tower, has become a landmark symbol of Paris. It was originally built for the World's Fair of 1889 and to celebrate the centennial of the French Revolution as a temporary display. Two engineers Emile Nouguier and Maurice Koechlin, in Eiffel's metalwork company proposed the idea in 1884. After submitting and receiving a patent for their design, they turned to an architect, Stephen Sauvestre to make the project more appealing to the eye. It was a tribute to the industrial age, where metalwork and man's achievement could be displayed for all to see. As time passed, it became an inspiration for artists and writers who helped in portraying the tower as a symbol of the city. In 2000 for the New Year's Eve celebration, the tower was festooned with lights and a large digital display. The lights continue to this day lighting up the tower after dark for 10 minutes on the hour.

All world class cities have distinguishing landmarks that set them apart from other cities; go see for yourself why Paris is a world capital, not only for its fashion and art. It is a city of great history and architectural design, no one event shaped this city into its current embodiment, but all together created its beauty and place in the world as the remarkable City of Light.

Eiffel Tower