PDHonline Course G230

Technology in Society

John R. Andrew, P.E.

PDH Online | PDH Center

5272 Meadow Estates Drive
Fairfax, VA 22030-6658
Phone & Fax: 703-988-0088
www.PDHonline.org
www.PDHcenter.com

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Technology in Society

John Andrew PE

Technology is the source of much prosperity and offers a bright new future for those nations that embrace it. The possibility of growing new organs from a few skin cells is nearby. The emerging hydrogen economy promises to replace gasoline in fuel cell driving cars and other vehicles is already a reality.

The seven sections of this 6 PDH course for engineers sketch some glimpses of Technology in Society.

CONTENTS

Above is the image in its **original context** on the page: **www.victorialodging.com/event/tall-ships-vict...**

America is undergoing a transformation that began about 200 years ago with the industrial revolution. The most advanced forms of transportation were the horse and wind driven sailing ship. Steam replaced wind and horse power. Steam engines came into wide spread use. Steam powered the machinery of industry, pulled trains carrying tons of cargo, and passengers from coast to coast on low friction steel rails. Steam engine driven propellers pushed huge ships across the Atlantic and Pacific oceans increasing trade between the United States and the rest of the world.

Above is the image in its **original context** on the page: **minnesota.publicradio.org/.../**

An innovation explosion followed the invention of the steam engine. Millions of automobiles suddenly appeared bouncing along bumpy dirt and gravel roads. Food production increased when tractors started to pull plows. Washing clothes in a tube of water with a scrubbing board by hand ended with the electric motor driven washing machine. The speed of the pony express was replaced with instant communication by telegraph and later telephone. Invisible radio waves brought news and entertainment to the average household. Motion pictures enthralled audiences.

Now the laptop computer above, is able to receive and transmit information in the form of: graphics, sound, text, and translate languages all over the world. Computers and cell phones have become a very important part of our lives and our lively hood. These inventions and many more have increased the quality of life and the wealth of the nation.

Unseen and unappreciated is the technology behind innovation. Did you know that Edison had to reduce the air pressure in his light bulb invention to one millionth of an atmosphere to make it produce light for many hours without burning out?

1. Science

A plaque in the Nation Science Foundation reads:

To science: pilot of industry

conqueror of disease

multiplier of the harvest

revealer of natures laws

eternal guide to truth

http://www.nsf.gov/about/glance.jsp

The National Science Foundation (NSF) is an independent federal agency created by Congress in 1950 "to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense…" With an annual budget of about $6.06 billion, we are the funding source for approximately 20 percent of all federally supported basic research conducted by America's colleges and universities. In many fields such as mathematics, computer science and the social sciences, NSF is the major source of federal backing.

We fulfill our mission chiefly by issuing limited-term grants -- currently about 10,000 new awards per year, with an average duration of three years -- to fund specific research proposals that have been judged the most promising by a rigorous and objective merit-review system. Most of these awards go to individuals or small groups of investigators. Others provide funding for research centers, instruments and facilities that allow scientists, engineers and students to work at the outermost frontiers of knowledge.

NSF's goals--discovery, learning, research infrastructure and stewardship--provide an integrated strategy to advance the frontiers of knowledge, cultivate a world-class, broadly inclusive science and engineering workforce and expand the scientific literacy of all citizens, build the nation's research capability through investments in advanced instrumentation and facilities, and support excellence in science and engineering research and education through a capable and responsive organization. We like to say that NSF is "where discoveries begin."

Many of the discoveries and technological advances have been truly revolutionary. In the past few decades, NSF-funded researchers have won more than 170 Nobel Prizes as well as other honors too numerous to list. These pioneers have included the scientists or teams that discovered many of the fundamental particles of matter, analyzed the cosmic microwaves left over from the earliest epoch of the universe, developed carbon-14 dating of ancient artifacts, decoded the genetics of viruses, and created an entirely new state of matter called a Bose-Einstein condensate.

NSF also funds equipment that is needed by scientists and engineers but is often too expensive for any one group or researcher to afford. Examples of such major research equipment include giant optical and radio telescopes, Antarctic research sites, high-end computer facilities and ultra-high-speed connections, ships for ocean research, sensitive detectors of very subtle physical phenomena and gravitational wave observatories.

Another essential element in NSF's mission is support for science and engineering education, from pre-K through graduate school and beyond. The research we fund is thoroughly integrated with education to help ensure that there will always be plenty of skilled people available to work in new and emerging scientific, engineering and technological fields, and plenty of capable teachers to educate the next generation.

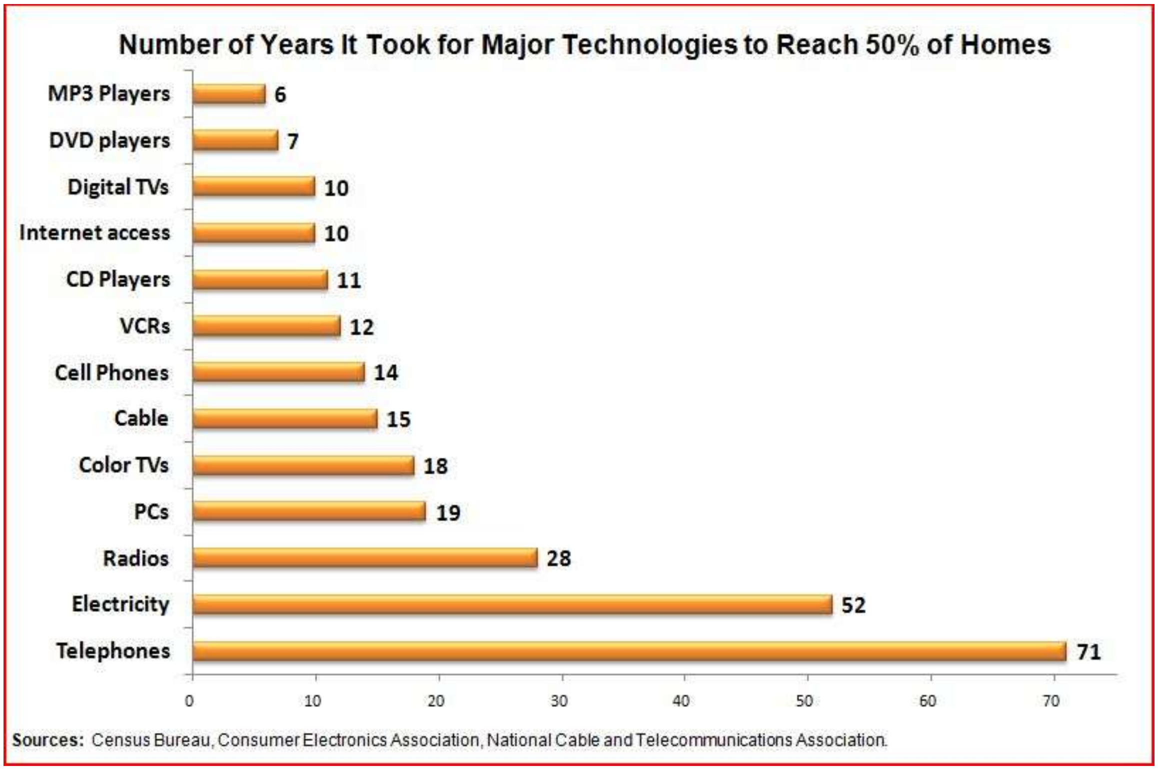
No single factor is more important to the intellectual and economic progress of society, and to the enhanced well-being of its citizens, than the continuous acquisition of new knowledge. NSF is proud to be a major part of that process.

You Can Make Discoveries

Einstein demonstrated that it is possible to make discoveries about science and technology while sitting in your arm chair thinking of a mental experiment. The reader is encouraged in this lesson to apply Einstein's method to find answers to important questions in: science, technology, engineering, the environment, and globalization. Start with a few definitions or postulates that are obviously true. Conduct mental experiments, make simple sketches, and calculations to make new discoveries about science and technology in our world today.

2. Technology

The importance of technology in society cannot be overstated. Technology began with the invention of simple tools, and continues today with: computers, cell phones, lasers, fuel-cells, medicines, new food production methods, and much other advancement that have improved the lives of billions of people around the world. Economics, values, ethics, the environment, government, and the military are all dependant on technological developments. Inventors apply the discoveries of science to technology. Entrepreneurs bring technology to the world market place with the aid of new mass production systems.



Years for Technology to Reach 50% of the US Population

The chart above shows that it took 71 years from the invention of the telephone until half of the population of the United States was able to purchase a phone. 28 years for radio. The time for each innovation to reach 50% of the population is less each year. Four years is all it took for half the country to have iPods.

Benefits of Technology

The World Bank has these objectives:

- **Job and wealth creation**
  Productive jobs tend to be created in private markets; competition tends to drive upgrading of skills and productivity growth, especially when backed by deeper and more liquid financial systems; in turn this raises real wages.
- **Opportunity for all**
  Rules-based markets that allow entry of new firms promote success on the basis of rules, not on the basis of personal connections; this stimulates movement from the informal to the formal sector including access to finance for underserved small firms and households.
- **Better governance**
  Better regulation reduces opportunities for corruption; wealth creation and entry of new parties into the market tend to create demand for better governance; corporate governance

and anti-money laundering activities directly provide greater transparency and remedies against abuse.

3. Engineering

Engineering has been defined as the art or science of making practical application of the knowledge of pure sciences, as physics or chemistry, as in the construction of engines, bridges, buildings, mines, ships, and chemical plants.

Engineering is also the action, work, or profession of an engineer.

Engineers specialize in one or more of the divisions: Chemical, Civil, Control Systems, Electrical and Computer, Environmental, Industrial, Manufacturing, Mechanical, Metallurgical and Materials, Nuclear, Petroleum, and Structural. Preparation for each of these disciplines requires a minimum of 4 years in college or university.

The Defense Advanced Research Projects Agency (DARPA)

http://www.darpa.mil/

DARPA is the central research and development organization for the Department of Defense (DoD). It manages and directs selected basic and applied research and development projects for DoD, and pursues research and technology where risk and payoff are both very high and where success may provide dramatic advances for traditional military roles and missions.

The DARPA Urban Challenge was held on November 3, 2007, at the former George AFB in Victorville, Calif. Building on the success of the 2004 and 2005 Grand Challenges, this event required teams to build an autonomous vehicle capable of driving in traffic, performing complex maneuvers such as merging, passing, parking and negotiating intersections. This event was truly groundbreaking as the first time autonomous vehicles have interacted with both manned and unmanned vehicle traffic in an urban environment.

4. Ethics

Ethics is about the good life. The best and most satisfying lifestyle is considered to be of the highest importance.

Ethics includes considerations of moral conduct and the analysis of right and wrong social systems. Pollution and weapons of mass destruction raise ethical questions. Another ethical concern is the disparity in technology between first and third world nations.

Each profession: Engineering, Medical, Law, etc. has a written code of ethics. Unfortunately these codes are not always followed. Disciplinary actions are enforced against individuals who deviate from the norm.

Most of the major corporations in the United States have a: Mission / Vision / Values statement. Typically they say:

Mission

To meet and exceed our customers: quality, delivery, and price expectations while creating a customer, employee, and supplier environment that is the high standard for all others to follow.

Vision

Create an environment that provides the highest quality products for our customers while guiding and developing the workforce to maximize their opportunities to grow, thus enhancing the general welfare of our communities

Values

To achieve total customer satisfaction by understanding and dedicating ourselves to our customer's needs, while embracing a philosophy of continuous improvement. Our core values are compassion, respect, honesty, integrity, and trust.

5. Cultural Diversity

Cultural diversity encompasses the cultural differences that exist between people, such as language, dress and traditions, and the way societies organize themselves, their conception of morality and religion, and the way they interact with the environment.

Diversity in the workplace, organization, even nation, has recently become a much touted goal.

Individual and groups of cooperating persons solving maze problems were modeled. The collective path length was found to be more productive and efficient than that of any individual.

Culture generally refers to patterns of human activity and the symbolic structures that give such activities significance and importance. Cultures can be "understood as systems of symbols and meanings that even their creators contest, that lack fixed boundaries, that are constantly in flux, and that interact and compete with one another. Different definitions of "culture" reflect different theoretical bases for understanding, or criteria for evaluating, human activity.

Culture is manifested in music, literature, lifestyle, painting and sculpture, theater and film and similar things. Although some people identify culture in terms of consumption and consumer goods (as in high culture, low culture, folk culture, or popular culture), anthropologists understand "culture" to refer not only to consumption goods, but to the general processes which produce such goods and give them meaning, and to the social relationships and practices in which such objects and processes become embedded. For them, culture thus includes art, science, as well as moral systems.

6. Environment

Some new technologies do as much harm as good, creating huge new challenges for the world: consider the motor vehicle, which symbolizes gridlock and pollution at least as much as it does freedom and affluence.

The purpose of the **Environmental Protection Agency, EPA** is to oversee and manage changes to the environment within the United States due to human intervention. Information about the EPA may be obtained from:

http://www.epa.gov/newsroom/newsreleases.htm

Are all environmental issues the responsibility of the EPA?

No, some issues are primarily concerns of other federal, tribal, state or local agencies. EPA also works in partnership with state environmental agencies. Many environmental programs have been delegated to the states and they have primary responsibility for them. Often, it is most appropriate to contact your local (city or county) or state environmental or health agency rather than EPA.

7. Globalization

The joint World Bank-IFC Financial and Private Sector Development Vice Presidency focuses on three core areas:

- Creating the institutional foundations for effective markets (examples: property rights, collateral systems, corporate governance, financial market infrastructure)
- Promoting open and competitive markets (examples: opening up entry, access to finance for promising firms, deeper and more liquid financial markets, and exit for failing firms)
- Supporting social safety nets with market-based instruments (examples: financial market-based instruments and risk management for pensions and insurance systems as well as low income housing)

This is the end of the Technology in Society 2008 Summary

1-SCIENCE

Science as it relates to technology observes and measures the real world. Science is observation plus logical reasoning. The physical laws of nature discovered by scientists are often employed in the technology and engineering disciplines in a useful way.

1.1 The Scientific Method

Engineers employ the six steps of the scientific method listed here when embarking on each new design and build project:

1. Ask a question.

2. Research the existing knowledge base.

3. Construct an hypothesis (guess the answer) to the question.

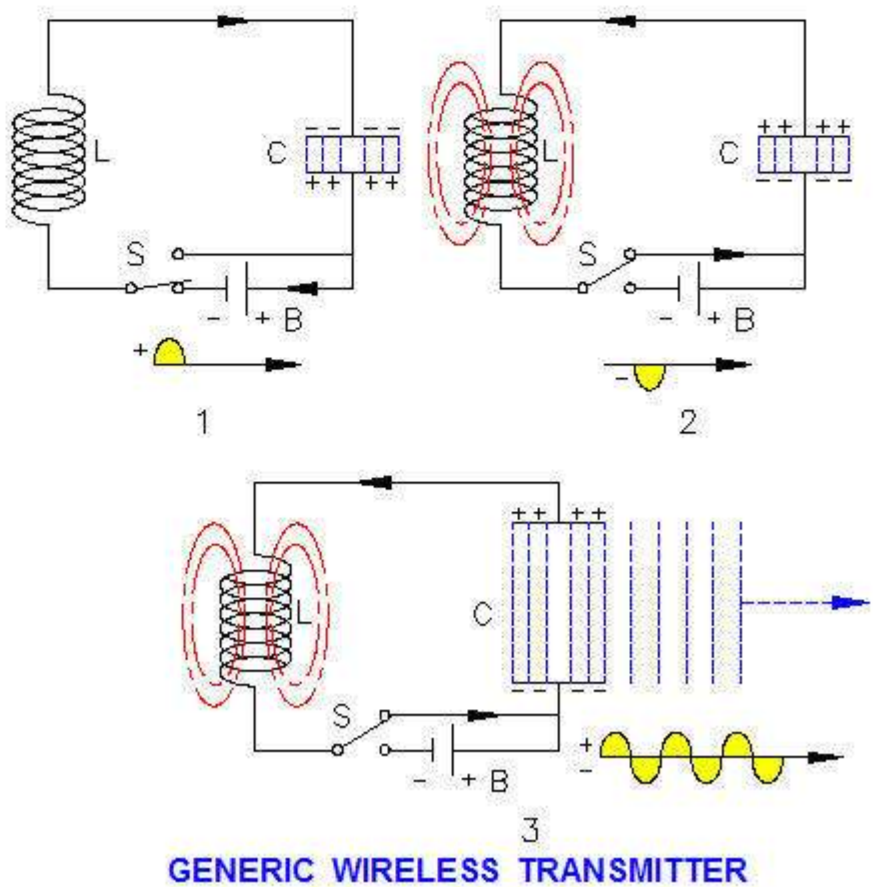
4. Test the hypothesis with experiments.

5. Analyze the data from the research and experiments.

6. Communicate the results.

1.2 Electromagnetic Radiation Transmission

Morse worked many years enduring extreme poverty to perfect instant communication by telegraph over insulated lines of wire. Today we transmit and receive information wirelessly by: Radio, TV, Cell Phones, and the Internet. These relatively new systems would not work without electromagnetic signal transmission. Consider the value of this phenomenon and the role played by technologists and engineers in the design, manufacture, and distribution of wireless products to society.



How are electromagnetic signals transmitted and received?

Figure 1 above shows a switch S connecting a battery B to an electric circuit containing a capacitor C and induction coil L. When the switch is closed a short pulse of electricity flows clockwise around the circuit charging one plate negatively and the adjacent plate positively with electrostatic energy.

Figure 2 shows the switch by-passing the battery and connecting the capacitor to the induction coil. A short pulse of electricity flows anti-clockwise around the circuit causing magnetic energy to be stored in the coil. The two plates of the capacitor become charged with opposite polarity.

Figure 3 shows short pulses of electricity flowing clockwise and then anti-clockwise around the Electrostatic energy is converted to magnetic and back again causing a current to flow in oscillations. When the frequency of the oscillations is high enough, electromagnetic radiation in the form of radio waves are transmitted at the speed of light.

The electromagnetic radio waves are received by an oscillator circuit similar to the transmitter above but with a variable capacitor. The receiver circuit has an adjustable frequency. When the receiver frequency matches the transmitted frequency it resonates.

1.3 Wireless Applications

Technologists and engineers have designed and manufactured many products employing wireless transmission: radios, TVs, cell phones, laptop computers, iPods, remote car door locks. Automobiles and many other products improve each year. Manufacturing systems and tooling must be able to change for the new models. Permanent hard wired industrial control systems are not viable for the new innovation-perfection demanding market place. The most flexible control systems use electromagnetic radiation called wireless transmission. Every stage of the manufacturing process from receiving raw materials to warehouse inventories are transmitted wirelessly from bar-code readers to computerized management systems.

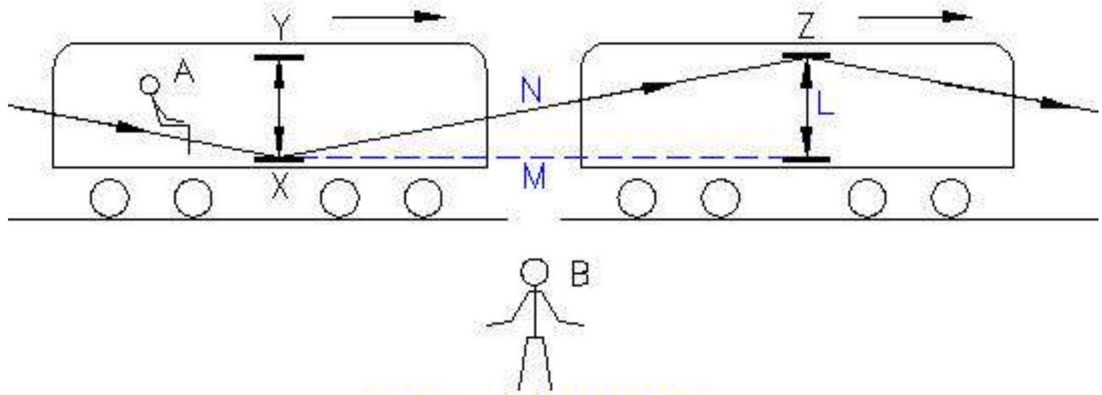
1.4 Albert Einstein's Discovery Method

Light is one form of electromagnetic radiation. Albert Einstein, the scientist, was curious about the nature of light. From a young age he wondered what it would be like to travel along side a light wave. His questions about the nature of light lead him to discover the relation between mass and energy expressed in the famous formula: $E = MC^2$ described in more detail below. This result came to be known as atomic energy. Technologists found ways to control this energy and engineers designed and build atomic power stations.

128.143.168.25/.../einstein2/ein_home.htm
Albert Einstein

1.5 Einstein's Light Clock

Albert Einstein in 1905 gave us the; "Theory of Relativity" and "Quantum Mechanics" while working full time six days a week as a patent examiner in Germany. Einstein demonstrated that it is possible to make discoveries about the universe while relaxing in an arm chair. His technique was to imagine what would happen to light in mental experiments.



Einstein's Light Clock

1.6 Mental Experiment-1

Einstein imagined a railway train speeding along a track. He began with simple postulates that were obviously true because they were so simple. Galileo wrote in 1660, that the laws of nature must be the same when objects are at rest and when the objects are moving in a straight line at constant velocity. Einstein referred to Galileo's principal in his first postulate.

Postulate-1: "The laws of physics are the same for any reference frame." A reference frame refers to the three mutually perpendicular directions: X, Y, Z, and time.
Postulate-2: "The speed of light is constant", proved earlier by 12 experimenters including Michelson and Morley.

Einstein asked us to imagine: observer (A) traveling in a railway carriage, from left to right above, while observing light being reflected from a mirror on the floor at (X) to a mirror on the ceiling at (Y) and back again repeatedly. Observer (A) measures the time for the light to reflect from (X) to (Y) and back again to be one tick of this, "light clock".

Observer (B) is standing on the ground as the carriage passes by at very high speed and measures the time for the light to reflect from (X) to (Z) and back again to be 4 times as long as one tick of A's light clock. Which light clock (A) or (B) gives the correct time?

Einstein said that the major discoveries of physical science came from deduction not induction. He used postulates-1 and 2 above to conclude that , "All observers should measure the same speed of light, no matter how fast they are moving at constant velocity". For this postulate to be true, time can not be the same for observers A and B. Therefore time is relative to the observer. If the carriage traveled near the speed of light for one of (B's) years and returned, (A) would have lived many years. This relative nature of time is known as time dilation or time warp.
The, "Time Dilation" formulas below refer to the light clock above
The math below could be accomplished by a high school graduate.

Velocity = distance traveled / time to travel.

L is the vertical distance between mirrors.

c is the constant velocity of light, 186,000 miles per second.

t is the time for light to travel from X to Y.

$L = c\,t$ ………………………………………………….. (1)

T is the time for light to travel from X to Z.

N is the distance from X to Z.

$N = c\,T$

v is the velocity of the train.

M is the horizontal distance traveled by the train in time t.

$M = v\,t$

$N^2 = M^2 + L^2$

$(cT)^2 = L^2 + (vT)^2$ ……………………………………….. (2)

Combining equations 1 and 2:

$(cT)^2 = (c\,t)^2 + (vT)^2$

$t^2 = T^2 – (v / c)^2\, T^2$

$t = T \sqrt{(1 – (v^2 / c^2))}$

$y = t / T = 1 / \sqrt{(1 – (v^2 / c^2))}$ …………………………… (3)

y is the time dilation factor. As the train's velocity approaches the speed of light c, time t, for an observer standing some distance from the passing train, becomes infinitely long.

$E = M\,C^2$

The famous equation: $E = MC^2$ means Energy (E) equals mass (M) times the velocity of light (C) squared. Einstein found this energy equivalence of mass was a consequence of the above time dilation factor (y), some high school algebra, and Postulate-3; the energy conservation principle:

Postulate-3: Total energy before equal's total energy after.

An object's energy before = objects energy after + emitted energy.

That's the situation as we see it from our own reference frame. The situation in any other reference frame differs only in the amounts of energy involved: the energy of an object is greater when it is moving that when it is stationary, and anyone moving past us will see the object as moving past them. But even in other frames of reference, the law of energy conservation still holds - total energy before equal's total energy after.

We can summarize the energy situation in both reference frames with two simple equations, one for the moving observer (m.o.) and one for us, the stationary observers (s.o.):

object's energy before (m.o.) = object's energy after (m.o.) + emitted energy (m.o.)

object's energy before (s.o.) = object's energy after (s.o.) + emitted energy (s.o.)

We can imagine a light bulb shining equally in all directions in our reference frame. In this case, if the emitted light has (to us) an energy L:

emitted energy (s.o.) = L

the emitted light has, to the moving observer, a higher energy:

$$\text{emitted energy (m.o.)} = L \times \frac{1}{\sqrt{1 - v^2/c^2}},$$

which is $1/\sqrt{1 - v^2/c^2}$ times greater than L. The "v" stands for the velocity of our moving observer (or the velocity that he sees the object moving), and the "c" stands for the speed at which light travels in a vacuum.

When we use these expressions for the emitted energy in the equation preceding them, we find the change that our moving observer sees in the object's kinetic energy:

object's kinetic energy before (m.o.)

= object's kinetic energy after (m.o.)

$$+ L \times \frac{1}{\sqrt{1 - v^2/c^2}} - L.$$

Two more facts and we are there.

First, as long as the velocity of our moving observer is not very large compared to the speed of light in a vacuum (our usual experience), the difference between the emitted energy as seen by us and the moving observer is approximately

$$\tfrac{1}{2} \times (L/c^2) \times v^2.$$

Second, under those same conditions, the kinetic energy of a moving object is approximately

$$\tfrac{1}{2} \times (\text{mass of the object}) \times v^2.$$

Since the velocity of the object as seen by the moving observer, "v", is the same after it emits the energy as it was before, the only way its kinetic energy can change is if its mass changes. Evidently, the mass changes by L/c^2 - by the energy the object emits (in our frame of reference), divided by the speed of light in a vacuum squared. Since, as Einstein pointed out, the fact that the energy taken from the object turns into light doesn't seem to make any difference, he concluded that whenever an object emits an amount of energy L of *any* type, its mass diminishes by L/c^2, so that the mass of an object is a measure of how much energy it contains.

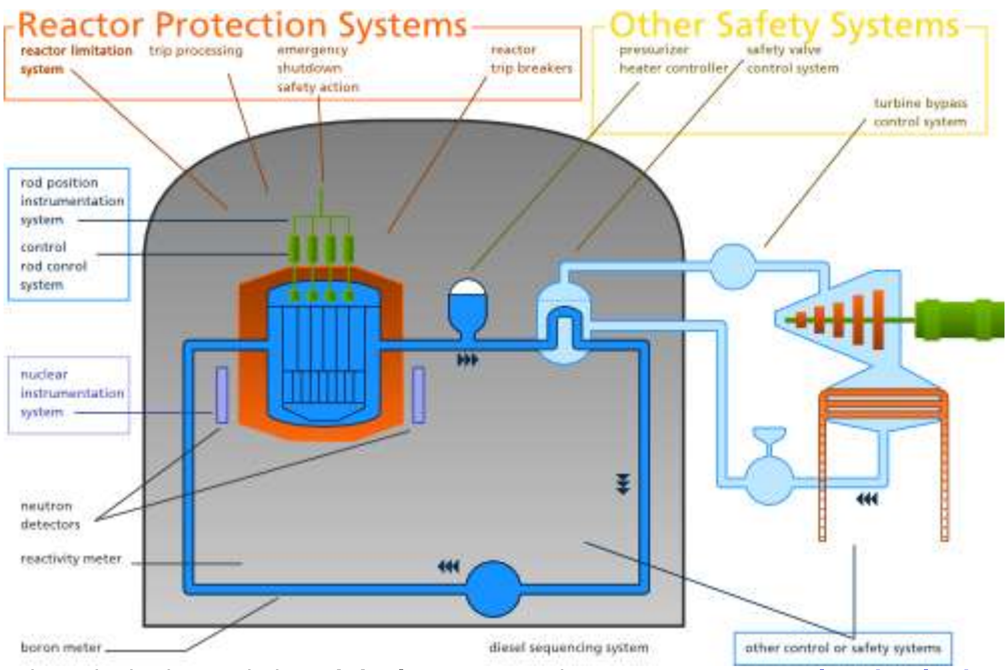
Einstein's first paper on relativity, states that the speed "c" is involved, not because we considered light instead of some other energy form, but because "c" is the speed at which time becomes, in a sense, equivalent to space, as the preceding article in this series illustrates. The fact that "c" is also the speed of light in a vacuum is coincidental. We would have found the same relation between mass and energy even if we had considered energy emitted in a form other than light, although it might have made the math more difficult.

Interestingly enough, Einstein first expressed his conclusion in about the same way we did above, without actually using the equation "$E=mc^2$". He only expressed the result that way later on.

Above article Ref: **$E=mc^2$ - What's the Speed of Light Got to Do With It? Link below**

http://www.osti.gov/accomplishments/nuggets/einstein/speedoflight.html

From Science to Technology



Above is the image in its **original context** on the page: **www.esterel-technologies.com/.../q2-2006**

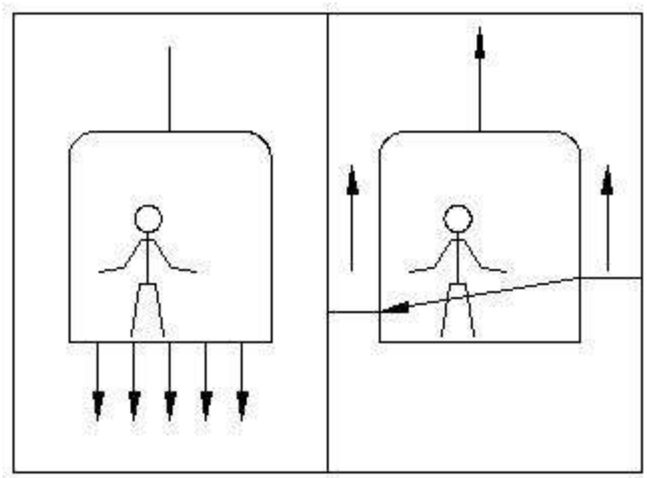
Atomic power station schematic, above.

The discovery of a scientist, Einstein using only the scientific method and pencil and paper found that there is an enormous amount of energy in a small mass of any material. His formula, **$E = m c^2$** was tested experimentally in the secret, “Manhattan Project” to help the war effort and found to be true. The atom bomb was born. Further research resulted in atomic energy that could be controlled. The atomic energy in uranium is used to heat steam to drive turbines. The spinning turbines rotate huge electric generators in atomic power stations that supply electricity to homes and industry. The quality of life of billions around the world has been improved through the use of atomic energy. We look to future technologies that will solve the nuclear waste problem.

1.7 Mental Experiment - 2

Einstein made another **mental experiment** that proved that light would bend in a gravitational field.

This is how he did it.



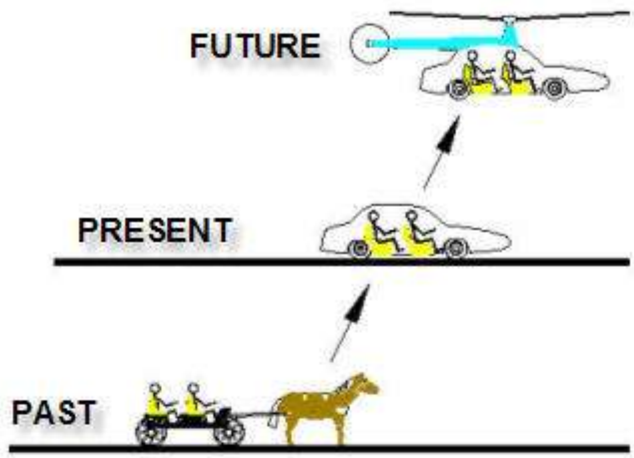
A person standing in a stationary elevator will have weight due to the earth's gravity. This weight is gravitational mass. Einstein told us to imagine the same elevator in space at a point where gravity is zero. The person would not feel his weight. Items would float in mid air within the elevator.

If the cable attached to the roof of the elevator is pulled upward at an acceleration of 32 feet per second per second, the person's full earth weight will return. This "weight" is inertial mass. Scientists knew that gravitational and inertial mass are the same but never questioned this postulate. Einstein did consider the equality of inertial and gravitational mass and deduced that gravity is the same as acceleration.

He asked us to imagine a light beam entering the elevator through a small slit in one side wall while it accelerated upward in space. The elevator is speeding upward while the light crosses from wall to wall. The light would reach the opposite side of the elevator at a slightly lower height from the floor. Einstein stated that light would behave the same way in a gravitational field. Light will bend toward a gravitational field. He made a request, "An astronomer should observe light from a star during an eclipse of the sun to see if the light would bend in the sun's gravitational field." A few years' later astronomers verified that light was bent by the gravity of the sun by the exact amount that Einstein had calculated.

Use Einstein's method to find answers to important questions in: science, technology, engineering, and globalization. Start with a few definitions or postulates that are obviously true.
Conduct: mental experiments, make simple sketches, and calculations. Maybe you will make new discoveries about, technology, the universe, and our world.

2-TECHNOLOGY



2.1 Past and Present Technology

Technology has changed the way people live, especially during the last 200 years. The automobile has replaced the horse drawn carriage. Millions of homes heated and cooled by heat pumps did not exist 50 years ago. Hand written business ledgers are now computer data bases. The time required to communicate information was limited by the speed of the pony express when my father was a child. Local newspapers and personal blogs are now read around the world on the internet at the speed of light. There are cell phones being developed today that are capable of speaking the written material they are reading.

The price of steel has doubled this year. Carbon fiber and various plastics are being considered for the manufacture of cars.

It is well known that Intel manufactures silicon computer chips. According to chief technology officer Patrick Gelsinger at Intel, they are developing tiny radio transceivers from the same material. A silicon wireless transmitter / receiver will be placed on the corner of every computer chip.

Genetic engineering has enabled animals to grow new replacement: hearts, kidneys, eyes, and other organs.

James Tour of Rice University is leading the way with, “Nanotechnology.” Molecular electronics has been validated to the tune of many millions of investment dollars. Products include: Ultrasensitive biological sensors, flat panel displays, and nanoscopic lasers. The dimensions of these innovations are measured in billionths of a meter.

2.2 Innovation Paths

Almost all products and enterprises must progress along an innovation path or they will become obsolete.

Sales of the Model-T Ford dropped after 15 million were sold in the early 1900's. All were painted black. Competing auto makers offered other colors, improved comfort, and reliability.

High volume standardized products can be very profitable. However the public will buy competing products if they have improved features or are available at a lower price.
Consider the vast amount of research and development that has gone into the form and function of the various elastomers:

jiefeng.en.alibaba.com/product/0/50070013/Pas...

rubber tires
elastic gloves
flexible hose
adhesives
sealing compounds
vibration dampers

The governor of Michigan appropriated funds for a $4.6 million National Elastomer Center for undergraduate technical training for even more research and development. Surely we know everything about the science and manufacturing of elastomers don't we?

No, we don't know everything about anything.

Research and development must continue in all areas of human endeavor in order to improve the quality of life for as many as possible. This is one example in the field of education, that demonstrates why the innovator, the inventor is so vital to any society.

picasaweb.google.com/.../_o8q7bll43x8gzPKbSgXrw

Many inventors and designers initiated over 5,000 new

computer related products displayed at the annual Comdex Exposition in Las Vegas.

One company that manufactures conveyors has recently added a 200,000 sq ft research and technology center. If this effort to facilitate innovation is being applied to conveyors, we can be reasonably certain that similar efforts are applied to advance and improve many other products.

2.3 CU-ICAR

Vision:

Clemson University International Center for Automotive Research will be the premier automotive and motor sports research and educational facility in the world.

Clemson University board of trustees approved a $4.8 million contract for construction of the Collaboration Plaza in CU-ICAR's Technology Neighborhood 1 by Manhattan Construction.

The plaza is the central gathering place for the first area of the CU-ICAR campus. Technology Neighborhood 1 includes the BMW Information Technology Research Center, the Timken Building, CU-ICAR executive offices, a public display gallery and the Carroll A. Campbell Graduate Engineering Center.

"This area will serve many different purposes. It will be the place where the public will first encounter

CU-ICAR, where we will display automobiles and where CU-ICAR partners and the public will interact," said CU-ICAR Executive Director Bob Geolas. "We are very excited to have

International Center for Automotive Research
Greenville South Carolina

: **www.ces.clemson.edu/.../cu-icar-plaza.htm**

Mission:

To establish world-class facilities for automotive/motor sports research.
To provide internationally recognized graduate automotive engineering programs.
To be the university/industry interface for the associated engineering, management, marketing and communication disciplines.

Wind Tunnel:

www.circletrack.com/.../photo_01.html

A full size car with breaks released can be pushed with one hand on the show room floor because friction is so small. Most of an automobiles engine power is needed to overcome aerodynamic drag on the freeway.

Noted aerodynamicist Gary Eaker has been operating his own private wind tunnel, pictured above in AeroDyn, in Mooresville, North Carolina, for a few years now. ICAR will have a large research and development wind tunnel similar to the one above.

The CU International Center for Automotive Research is located in Greenville South Carolina.

2.4 Inventions Satisfy Needs

It has been said that need is the mother of invention and war is the father.

Inventions have improved the quality of life for many millions around the world. As conditions change in a society, needs change. All of the following inventions from the past are continuously being improved by a new army of inventors. Everything from the automobile to jogging shoes, are becoming more user friendly and more complex.

2.4.1 The NCMR Inventing Method

The author of this course has summarized the inventing method in the PDHonline course G186: “Inventing by the NCMR Method. Motivated by **Need** Inventors **Combine** existing items **Modify** them to fit and function together, unnecessary portions are **Removed, (NCMR).** Inventors do not create something out of nothing. Every invention is a combination of existing items.

How many items, can you name from the list below, that our society could do without?

Item Needs Satisfied

Aluminum Alloys.........Aircraft - Engines - Car Parts

Battery..........................Car Starter - Flashlight - Calculator – Watch

Camera........................Video, Record Keeping – Pictures

Computer......................Typing - Databases - Spread Sheets - CAD

Diesel Engine...............Cars - Buses - Trucks – Ships

Electric Motor...............Machinery - Car Starter + Windows + Seats

Electricity Generator…Lighting - Heating - Cooling

Gasoline Engine.......... Cars - Buses - Trucks – Boats

Heat Resistant Glass...Cookware - Chemical Industry

Laser............................Measurement - Surgery - Weapons

Loom........................... Cloth - Fabrics – Carpets

Man Made Fibers.........Clothing - Aircraft - Heat / Sound Insulation

Motor Car & Truck…....Transportation - Cargo Delivery

Paper........................... Copy Paper - Writing Paper - Book Pages

Plastic ……………........Bottles - Containers - Cabinets - Packaging

Printing Press............. Books - Magazines – Newspapers

Refrigerator..................Food Storage - Food Processing

Radio............................Entertainment - News - Sports – Music

Robots………………….Assemble, Weld, Paint, Test

Satellites …………….... Radio - TV - Computer - Telephone

Sewing Machine..........Clothing – Upholstery

Solar Cell.....................Calculators - Satellite Batteries

Solenoid.......................Car Power Locks - Valves

Steam Turbine..............Electrical Power - Trains - Ships

Stainless Steel.............Utensils – Food/ Chemical Processing

Telephone.....................Mobile Communication **Transistor**......................Radio - TV - Computer - Telephone

TV................................. Entertainment - News - Sports - Music

2.5 Inventions Create Wealth

The creativity of inventors and entrepreneurs are the root source of our wealth. Their innovations have changed the United States from a relatively poor farming country 100 years ago, into an extremely wealthy industrialized nation today. Every: new car, cell phone, or other product sold increases wealth. Each product requires a service to sell and maintain it. The poverty seen in under developed areas is due to the lack of goods and services found in more prosperous regions.

Millions of Model-T Fords were planed to be produced in the early 1900's but there was not enough money in circulation for people to buy them. Henry Ford divided the manufacture of the automobile into hundreds of small operations that could be performed on an assembly line by unskilled labor. The motor company was able to show the value of cars to be manufactured in the coming years in their accounting books.

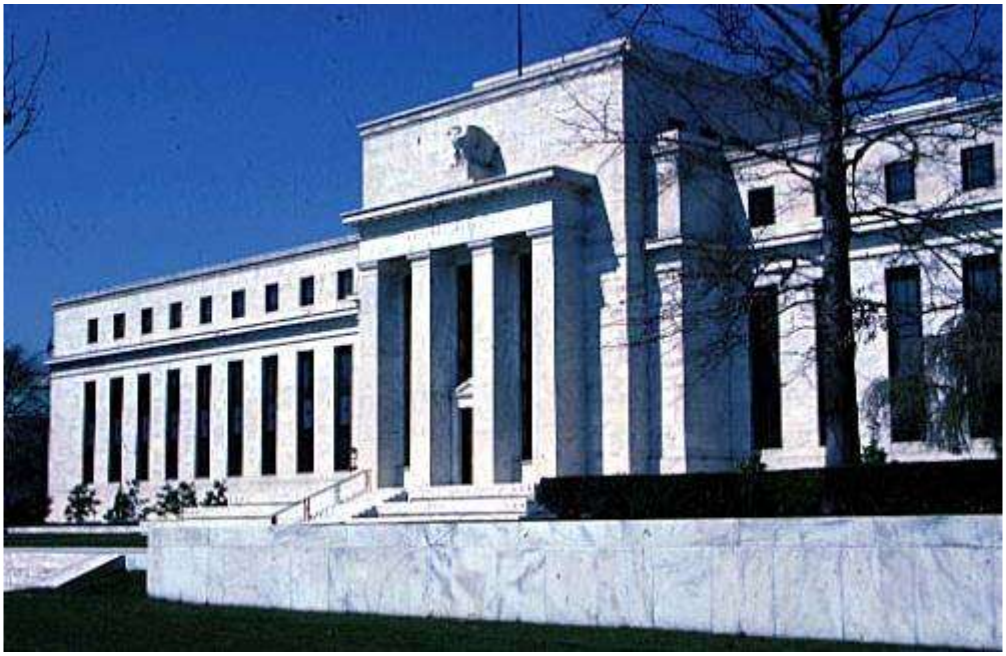
Banks provided the funds based on these numbers. More inventions manufactured by new businesses continue to generate increasing wealth.

2.6 A Small Business

A small business of 4 friends working in a garage manufacturing the new telephone invention by Alexander Bell in 1900, would buy $100 worth of raw materials. These workers would make, say 40 telephones during the following week and pay themselves a total of $200 in wages. Overhead expenses of $100 would include the lease on buildings, the cost of tools and coal for the furnace, taxes, etc. In this case the total cost to manufacture the 40 telephones in one week is $400, or $10 for each phone. These phones would be offered for sale at a price buyers were willing to pay, say $20 each. Before the first of the phones were sold, the general ledger would show a profit of 100% and a $400 increase in wealth on paper.

In this way new wealth appears in the accounting books of manufacturing companies today. As companies increase production to meet rising demand for products, they request loans from banks to purchase buildings, new equipment, and raw materials, increasing our nation's wealth and providing more jobs. The manufactured goods are warehoused and distributed by other companies who buy these products at wholesale prices, mark them up, and sell at higher values to retail businesses. This increases the value or wealth also. Retail shops add their profit and overhead to the wholesale price, increasing total wealth once more.

Businesses of all kinds borrow money from banks in proportion to the wealth shown on their accounting books. Banks borrow money from the Federal Reserve. They pay a low interest to the Federal Reserve. Banks receive a higher interest from loans to businesses.



www.gold-prices.biz/index.php?s=scam

2.7 The Federal Reserve

The Federal Reserve System, also known as "The Fed," is the central bank of the United States, above. In its role as a central bank, the Fed is a bank for other banks and a bank for the federal government. It was created to provide the nation with a safer, more flexible, and more stable monetary and financial system.

The Federal Reserve's responsibilities include:

- conducting the nation's monetary policy to help maintain employment, keep prices stable, and keep interest rates relatively low
- supervising and regulating banking institutions to make sure they are safe places for people to keep their money and to protect consumers' credit rights.
- providing financial services to depository institutions, the U.S. government, and foreign central banks, including playing a major role in clearing checks, processing electronic payments, and distributing coin and paper money to the nation's banks, credit unions, savings and loan associations, and savings banks.

As time goes on more money needs to be put into circulation to represent the new wealth created by a multitude of businesses. Each year more money needs to be printed to keep up with the increasing amount of goods sold and services provided. As a result of the expanding economy, more money is paid in wages and benefits to the workers who produced the goods.

We have a compulsion to shop for every kind of gadget that the innovators sell. We have a strong and growing economy because of all the widgets and gadgets that have been invented and manufactured and the associated services required to warehouse, sell, and maintain them.

Undeveloped countries have a lower standard of living because they do not do what we do: invent, manufacture, and sell new and improved products in large quantities.

2.8 Links to Inventions

1. www.uspto.gov

2. http://inventors.about.com/od/astartinventions/a/FamousInvention.htm

2.9 Thomas Alva Edison

(February 11, 1847 – October 18, 1931) was an American inventor and patented 1,093 inventions including:

* Light Bulb.
* Electrical Power Distribution System,
* Motion Pictures,
* Improved Recorded Music.

These innovations have grown into multi-billion dollar industries today. Edison was a: scientist, inventor, manufacturer, and entrepreneur. There are many lessons to be learned from successful inventors.

Thomas Edison is shown with his recording device on 21 November 1877 that Edison announced the invention of the phonograph.

Above is the image in its **original context** on the page: **old-photos.blogspot.com/.../thomas-edison.html**

Thomas Edison, above began his career as an inventor in Newark, New Jersey, with the automatic repeater and his other improved telegraphic devices, but the invention which first gained him fame was the phonograph in 1877. This accomplishment was so unexpected by the public at large as to appear almost magical. Edison became known as "The Wizard of Menlo Park," New Jersey, where he lived.

Edison's Team

Three men worked long hours for many years with Edison. Christopher Bachelor converted Edison's sketches into patent and working drawings. John Cruzy made working models. Edward Johnson wrote patent applications, payrolls, and contracts. The US Patent Office (www.uspto.gov) honors Edison by using a light bulb as their logo. They lived close together near the Menlo Park, New Jersey, research laboratory working long hours often through the night.

The first light bulb Edison invented required high electrical current because it had low resistance, about 2 Ohms. This meant high cost large diameter copper wires over long distances. He consulted with Faraday and learned the science of electricity. He was now able to calculate the resistance of a light bulb, 100 Ohms that would needed to reduce the diameter and cost of the cable supplying electricity.

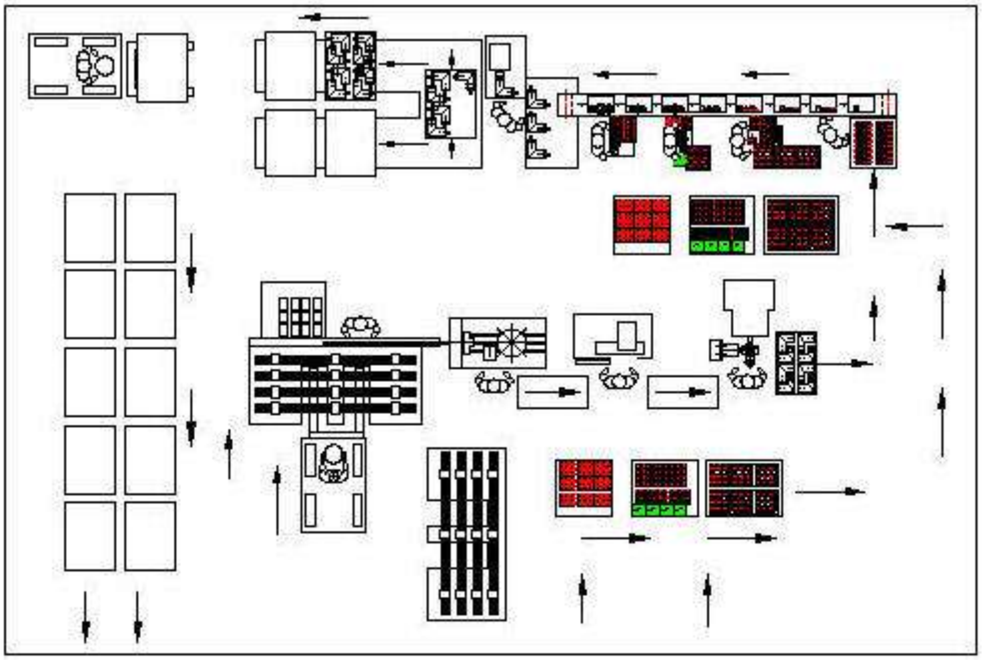
Edison allowed cost to direct the inventing process.

In 1880, Edison was the only person in the world capable of calculating the cost of electric lighting. He calculated the cost of: equipment, materials, and labor to build the world's first electric power distribution system that would provide electric lighting to 240 homes, less than 1 cent per hour.

A high resistance light bulb would illuminate while connected to low cost, small diameter wire. Hundreds of hours were devoted to testing different materials for the filament in the light bulb before one with high resistance and long life was found. Edison and his three faithful associates, succeeded in making a 100 Ohm bulb that would burn for many hours and that could be manufactured and sold at a profit. Thomas Edison became a multimillionaire because he owned and managed the manufacture of the light bulb and the electrical power supply system.

Manufacturing generates far more income than inventing alone.

He announced in a leading New York newspaper that he could illuminate one half square mile of lower Manhattan with electric lighting. The Westinghouse Company had paid him large sums of money for his telegraph patents. He used these funds to manufacture: dynamos, switches, fuses, light bulbs, and all equipment required for the worlds first electrical power and light, distribution system.



FINISHED PRODUCT OUT RAW MATERIALS IN

MANUFACTURING PLANT

In 1915 Edison had 3,600 workers in his factories manufacturing 30 different products with $25 million in annual sales in the USA and Europe. His companies were worth 5 billion dollars at the time of his death.

Edison's Inventing Methods

Edison's journal for 1872 has 100 sketches which developed into 34 patents. When he could not make an invention work he would put it aside and work on a different project. He wrote in his notes, "The first thing I knew, the very idea I wanted would come to me".

If faced with a difficult problem, we should allow time for our subconscious mind to do its work. Teamwork can be more effective than going it alone.

Edison did not know how he invented. He wrote in his diary one Valentines Day, "My wife Mary, dearly beloved, doesn't know how to invent worth a dam!" If he knew how he invented, he would have been able to teach his wife and others. I believe that most industrial designers and innovators do not understand the creativity process.

Method-1. One factor in Edison's inventiveness was his strong sense of people's needs. This drove him to invent. He stated, "I want to see a phonograph in every American home". He wanted everyone to be able to enjoy listening to music.

Method-2. If Edison could not solve a complicated invention problem, he would sketch a parallel device or build a model. His quadruplex invention is an example. There was a need to transmit 2 telegraph messages from station A to B at the same time 2 other messages were being sent from B to A on the same wire. Edison built a model of tubes and valves that would allow pumped fluids to represent electrical telegraph signals. He solved a complex problem in uncharted territory by making a model of a simpler known process.

Method-3. Edison had health problems as a child that caused him to miss much of the normal schooling program. He was filled with self confidence but uneducated. In his middle years he saw a dynamo used for outdoor, "sub-divided lighting" (several arc lights) for the first time. He exclaimed with great confidence that he could illuminate millions homes. Arc lights were far too bright and dangerous for domestic use. However he placed a notice in the New York newspaper proclaiming that he would install electric lights in thousand of homes in the city. He knew that if he worked hard enough and long enough he could invent an electric light bulb for illuminating homes.

Method-4. Edison worked long tedious hours for most of his life. It is well known that he experimented hundreds of times with different filament materials for his version of the light bulb. His persistence and that of his three faithful workers resulted in the first successful incandescent light bulb. It has been said that, "Persistence wins over intelligence".

2.10 Inventors of Note

James Watt - Steam Engine

Watt combined Newcomen's steam pump with a flywheel, connecting rod, and cams operating valves to become the first steam engine.

Orville and Wilbur Wright - Airplane

The two brothers combined the glider with an engine to become the first airplane.

Alexander Graham Bell - Telephone

Bell modified the telegraph transmitter to become telephone.

George W. Carver - Chemicals / Printers Ink / Soap / Varnishes

Carver processed peanuts to become 325 different chemicals.

Guglielmo Marconi - Radio

Combined an electric coil invented by Hertz with an instrument for recording electromagnetic waves called a coherer which became the first wireless transmitter. Think of how many things operate by wireless radio transmissions. We use: cell phones, open car doors, connect computers to the internet, etc wirelessly.

2.11 The Subconscious Mind

Your subconscious mind works day and night to solve your most urgent problems. You open the door of your car and suddenly the answer to a financial problem comes to you, "out-of-the-blue-sky". Your conscious mind was concerned with the immediate need to get to work on time while the subconscious found a solution to a long term need. We should allow our subconscious mind time to process things that concern us. Do not give up if you do not know the answer to a problem instantly. A complex design problem may take days or months to solve. The answer usually comes to you when you least expect it.

2.12 Idea to Marketplace

The inventor needs to be aware of 7 steps from invention idea to marketplace as listed below. All stages from invention idea to market place require innovation. New products require new tools and manufacturing facilities to make them.

Bring your invention to the market place!

Step 1. Idea Conception

Use the NCMR process specified in this book to create a new and useful, apparatus or method.

Step 2. Patent Disclosure

You or your Patent Attorney should make a search of the Patent Office files at the U.S. Patent and Trademark Office web address: www.uspto.gov to see if your invention has been patented.
If not, mail a patent disclosure statement (see below) with labeled drawings describing the novelty and usefulness of your invention together with a $10 fee to the Patent and Trademark Office to obtain 2 years of intellectual property protection and establish the date of origination and your name as the inventor until a full patent is applied for and granted.

Step 3. Patent Protection

Write a patent specification yourself (see below) or employ a patent attorney to write it.
The U.S. patent examiners critique applications from private individuals and patent attorneys and grant a patent or make suggestions as to corrections needed to qualify for a patent. The Patent process can take 2 years or more.

Step 4. Prototype Drawings

2.13 Future Technology

We can expect new developments in technology to replace the car with airborne vertical take off and landing vehicles that do not need roads. Robot butlers will serve us at the dinner table. Entire walls of our homes will present 3-dimensional holographic television. New organs will be grown from single cells of our own bodies. Human life span will be extended indefinitely. The technology to destroy will be so powerful that peace will be maintained. Below Paul McElroy gives his vision of the future.

Published by BTexact Technologies -
a division of British Telecommunications plc
Adastral Park, Martlesham
Ipswich IP5 3RE, UK
Email
btexact@bt.com

Paul McIlroy produced the first timeline in 1991 and it has been updated about once every two or three years. This is the 5th edition, and the biggest yet. A new editor Ian Neild has joined me on this edition and brought a welcome freshness to the timeline.

The timeline is produced mainly to give BT researchers and managers a view of what the operating environment is likely to contain at any future date, so that our products and services can be better targeted to the needs of the customer.

Artificial Intelligence models used extensively in business management 2010.

Artificial Nervous System for autonomous robots 2010.

Highest earning celebrity is synthetic 2010.

Smart Barbie with personality chip and full sensory input 2010.

Artificial Intelligence houses which react to occupants 2010.

25 % of TV celebrities synthetic 2010.

Expert systems surpass human learning and logic abilities 2011.

Most software written by machine 2011.

Home manager computer 2011.

Machine use of human-like: memorizing, recognizing, and learning 2012.

Computer agents start being thought of as colleagues instead of tools 2013.

Satellite location devices implanted into pets 2015.

Office Automation systems using functions similar to brain functions 2015.

Machine use of human-like creativity 2015.

Leisure activities for intelligent software entities released 2015.

Human knowledge exceeded by machine knowledge 2017.

Electronic pets outnumber organic pets 2020.

Electronic life form given basic rights 2020.

Artificial insects and small animals with artificial brains 2020.

Remote control devices built into pets 2020.

Ubiquitous (being everywhere at the same time) embedded intelligence 2020.

Virus wipes out half of the electronic pet population 2021.

Learning superseded by transparent interface to smart computer 2025.

Robots physically and mentally superior to humans 2030.

Living genetically engineered Furby (TM, Tiger Electronics) 2040.

3-ENGINEERING

3.1 Engineering and Technology

Technology began with the invention of simple tools, and continues today with innovations: computers, cell phones, I-phones, lasers, fuel-cells, wonder drugs, new food production methods, satellites, and many more advancements that have improved the lives of billions of people around the world. Economics, values, ethics, the environment, government, and the military are all dependant on technological developments. Inventors apply the discoveries of science to technology. Entrepreneurs bring technology to the market place with the aid of engineers.

Engineering includes the: concept, design, and building of: cars, computers, robots, factories, chemical processing, power generating plants, buildings, bridges, roads, space stations, etc.

3.2 Spreadsheet Calculations

Some advantages of spreadsheet calculations over hand written include:

1. easier to read.
2. better recall from archives.
3. greater accuracy.
4. faster with repeat use.
5. graphs are created automatically.
6. numerous useful formulas.
7. "Goal Seek" enables optimization.
8. solve any equation with, "Solver".
9. solve sets of linear and non-linear equations.
10. calculations and graphs may be pasted into documents and slide show presentations.

Spreadsheet Example

Four parameters are input in the example below and all calculations are performed by Excel, Open Office, or other spreadsheet.

Air Standard Otto Cycle Example — **Input**

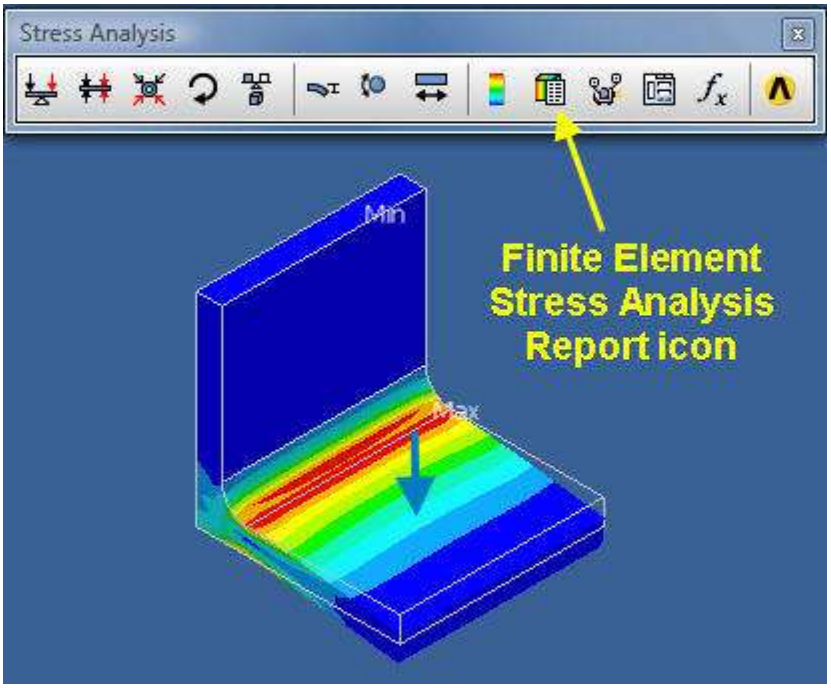
Compression ratio, r = V1/V2 =	10	-
Low temperature, t1 =	200	deg C
Low pressure, P1 =	200	kPa
Work output, Wout =	1000	kj/kg
	Calculation	
Specific heat ratio for air, k = Cp/Cv =	**1.4**	
Otto cycle efficiency, η =	**1 - (1 / (r^(k - 1)))**	
=	**60.2%**	
T1 =	**t1 + 273**	
=	**473**	**deg K**
1-2 is isentropic, T2 =	**T1*(v1/v2)^(k-1)**	
=	**T1*(r)^(k-1)**	
=	**1188**	**deg K**
Air specific heat constant vol, Cv =	**0.717**	**kj/kg deg C**
Air specific heat constant pressure, Cp =	**1.00**	**kj/kg deg C**
Given cycle net work, Wout =	**1000**	**kg/kg**
and Otto cycle net work, Wout =	**Cv*(T1 - T2) + Cv*(T3 - T4)**	
T3 - T4 =	**(Wout - Cv*(T1 - T2)) / Cv**	
T3 - T4 =	**2110**	**Equation-1**
3-4 is isentropic, T3 =	**T4*(v4/v3)^(k-1)**	
=	**T4*(r)^(k-1)**	
T3 / T4 =	**(r)^(k-1)**	
T3 / T4 =	**2.512**	**Equation-2**
Solving equations 1 and 2 simultaneously:		
T3 =	**3505**	**deg K**
T4 =	**1395**	**deg K**
Carnot cycle efficiency, ηcarnot =	**1 - T_{LOW} / T_{HIGH}**	
=	**1 - (T1 / T3)**	
=	**86.5%**	

3.3 Engineering with CAD

AutoCAD, "INVENTOR" easy to use software enables engineers to create digital prototyping of: Process Piping, Structures, Machine Parts and Assemblies with Autodesk® Inventor® software enables users to engineer, visualize, and simulate static and dynamic motions and analyze strength of products digitally.

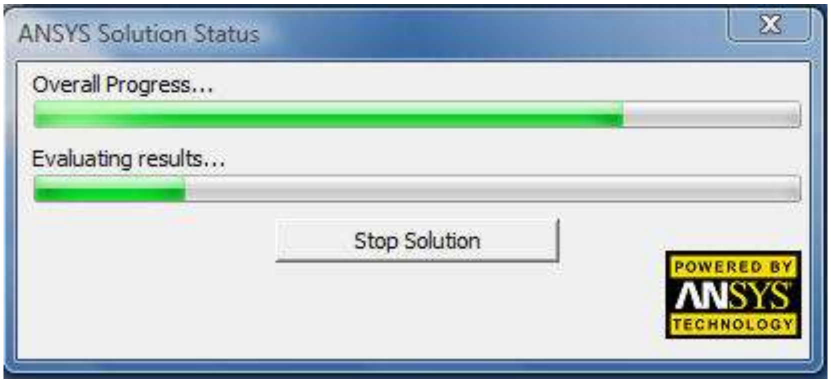
Linkages move, pistons reciprocate, gears and cams rotate in Inventor.

Course G280 AutoCAD Inventor - Solid Modeling, Stress and Dynamic Analysis is available at www.pdhonline.org/



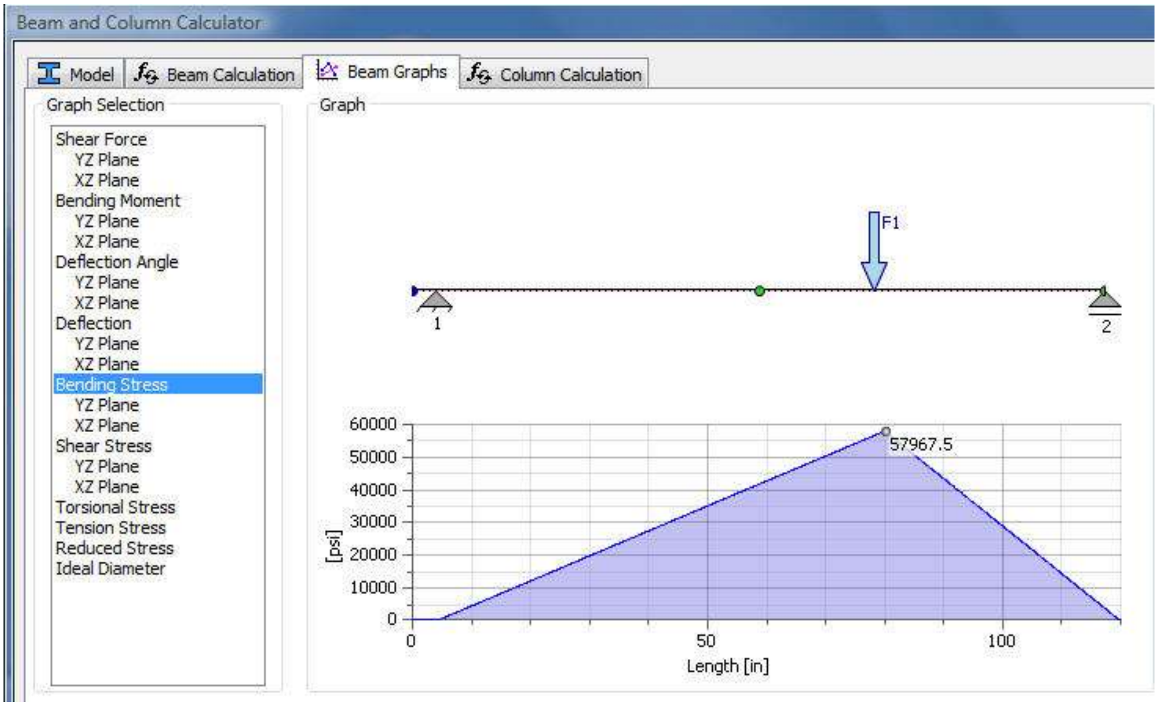
1. Above: Create the 3D solid model and place a load with the mouse pointer.

2. Select finite element analysis from the drop down menu with Inventor.

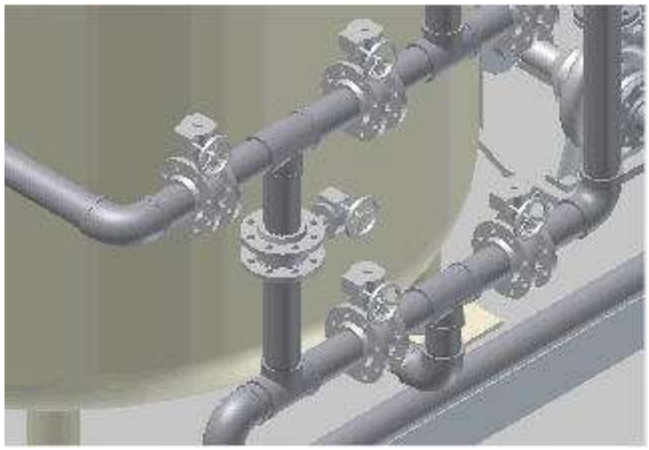


3. In less than 30 seconds ANSYS performs the finite element analysis and determines deflections and stresses.

4. Create gears automatically and make them rotate with Inventor.



5. Analyze the strength and stiffness of standard and none standard beams and columns with Inventor.



6. Create process piping systems semi-automatically with Inventor as above.

3.2 The Sky Car

http://blogs.chron.com/lightflight/archives/moller-skycar.jpg

Mr. Moeller: invented, patented, and engineered the skycar pictured above. One high power rotary engine drives a ducted fan in each of the four pods. This vehicle has been engineered to take off and land vertically, hover, and fly like an airplane. The automated controls are simple for the driver to operate. Several prototypes have been flown close to the ground. A large parachute is installed in the tail section for an emergency. More testing will be required to ensure stability and safety.

http://limpiaparabrisas.org/hydrogen_fuel_cells/Hydrogen_files/image004.jpg

Hy-wire Fuel Cell Car

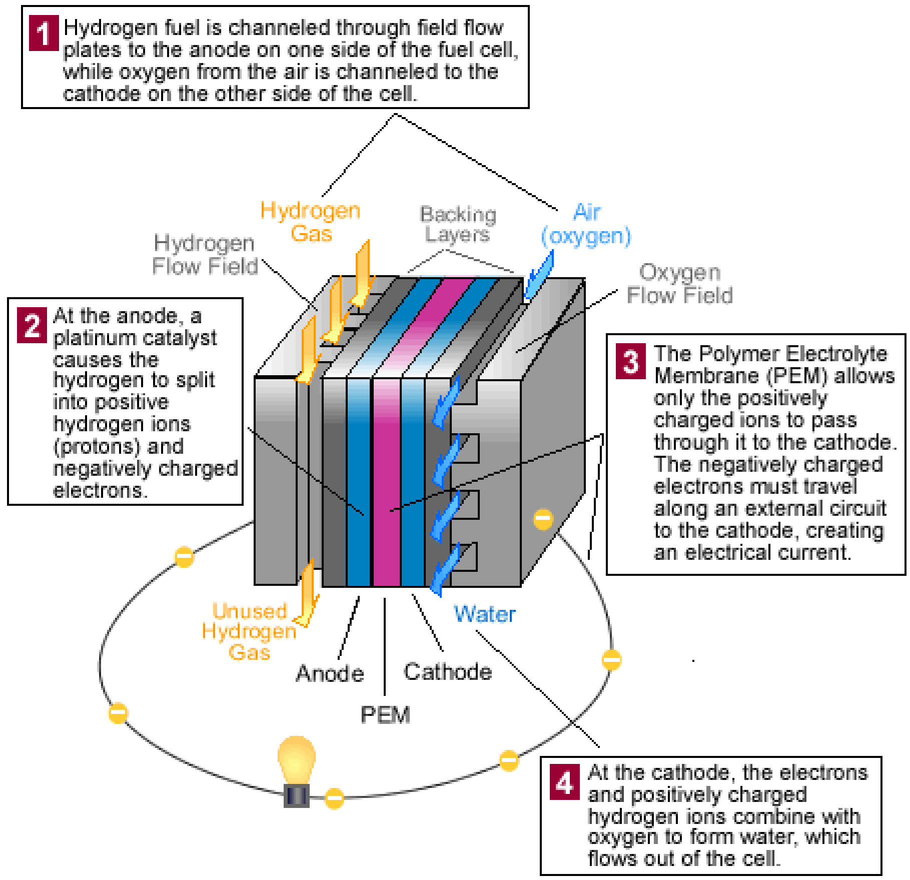
3.3 Fuel Cell Powered Cars

Larry Burns, GM's vice president of research and development and planning, said, "We are driving to have compelling and affordable fuel cell vehicles on the road by the end of the decade. With Hy-wire, we have taken the technology as it exists today and packaged it into an innovative drivable vehicle comparable in size and weight to today's luxury automobiles**.**

Above is the image in its **original context** on the page:
www.theautochannel.com/.../08/14/145651.html

"All of the touring sedan's propulsion and control systems are contained within an 11-inch-thick skateboard-like chassis, maximizing the interior space for five occupants and their cargo.

There is no engine to see over, no pedals to operate - merely a single unit called X-drive that is easily set to either a left or right driving position."



A typical fuel cell is illustrated above.

Above is the image in its **original context** on the page: **www.hydrogencarsnow.com/hydrogen-fuel-cells.htm**

3.4 Hydrogen Can Replace Gasoline

Hydrogen fuel cells can replace gasoline to power: cars, trucks, trains, and ships.

Existing technology is able to extract hydrogen from methane. New technologies will allow hydrogen to be extracted from the oceans (H2O) economically.

Hydrogen – AIKEN SC

http://www.fuelcellsworks.com/Supppage4489.html

The author of this course lives in South Carolina. This state has big advantages. In addition to a world-class hydrogen fuel cell laboratory at the University of South Carolina and automotive and transportation hubs at Clemson and S.C. State universities, the newest U.S. Department of Energy national laboratory is the Savannah River National Laboratory, started in 2004.

"It has a $139 million annual budget from the federal government and a concentration of hydrogen researchers (90) that may be the largest in the U.S. and even the world," the report states.

In fact, the state ranks 12th nationally in DOE hydrogen projects, fourth in hydrogen storage projects and third in hydrogen delivery projects, according to the 2005 Hydrogen Program Review.

Fox News, 12 Feb 2006, reported 700 new hydrogen related jobs in Aiken SC.

Ref: http://www.energy.gov/news/3088.htm

3.5 Fuel Cell Research at Cornell University

ITHACA, N.Y. Oct. 31, 2003 The U.S. Department of Energy (DOE) has awarded Cornell University $2.25 million over three years to establish the Cornell Fuel Cell Institute (CFCI). The institute will research new materials to kick-start the development of fuel cells that would be both efficient and cheap to produce.

Cornell researchers kick-started fuel cell development with $2.25 million federal award to find new materials for cheap, efficient technology

Contact: David Brand
Office: 607-255-3651
E-Mail: deb27@cornell.edu

3.6 Engineering Disciplines

The, “NATIONAL COUNCIL OF EXAMINERS FOR ENGINEERING AND SURVEYING” based in Clemson University, South Carolina, has specified the exam subjects for all branches of engineering in the United States.

Chemical Plant

Above is the image in its **original context** on the page: **www.lansdowne-**

photography.co.uk/industrial.htm

Engineers specialize in one or more of the disciplines: Chemical, Civil, Control Systems, Electrical and Computer, Environmental, Industrial, Manufacturing, Mechanical, Metallurgical and Materials, Nuclear, Petroleum, and Structural. Preparation for each of these disciplines requires a minimum of 4 years in college or university.

www.americanstampco.com/MARYLAND%20ARCHITECT.htm

State Codes generally require the architect or engineer in responsible charge of a project to

assume responsibility for the safety of design of the project. "The stamp and signature of the architect or engineer on a plan, specification, or other document shall be deemed evidence that full responsibility is assumed by the signatory for work shown.

Engineering Technician

A two year technical college Associate Degree in engineering will qualify a student to work under the supervision of a registered engineer.

Code of Engineering – See module-4 Ethics.

3.7 Professional Engineering Exam

http://www.ncees.org/

Four year graduate students desiring to become registered professional engineers must pass the two part exam: "Fundamentals of Engineering" (FE) and "Principals and Practice of Engineering". These exams require two days. Both exams are 4 hours during the morning followed by 4 more hours in the afternoon. All engineering disciplines must pass the FE exam unless exempted on the basis of years of experience working under the direction of registered engineers. All examinees must pass the Principals and Practice of Engineering exam.

Fundamentals of Engineering (FE) Examination
Effective October 2005

• The FE examination is an 8-hour supplied-reference examination: 120 questions in the 4-hour morning session and 60 questions in the 4-hour afternoon session.
• The afternoon session is administered in the following seven modules—Chemical, Civil, Electrical, Environmental, Industrial, Mechanical, and Other/General engineering.
• Examinees work all questions in the morning session and all questions in the afternoon module they have chosen.

MORNING SESSION

(120 questions in 12 topic areas)
Topic Area Approximate Percentage of Test Content:

I. Mathematics 15%
II. Engineering Probability and Statistics 7%
III. Chemistry 9%
IV. Computers 7%
V. Ethics and Business Practices 7%
VI. Engineering Economics 8%
VII. Engineering Mechanics (Static's and Dynamics) 10%
VIII. Strength of Materials 7%
IX. Material Properties 7%
X. Fluid Mechanics 7%
XI. Electricity and Magnetism 9%
XII. Thermodynamics 7%

AFTERNOON SESSION IN MECHANICAL ENGINEERING

(60 questions in 8 topic areas)
Topic Area Approximate Percentage of Test Content

I. Mechanical Design and Analysis 15%
II. Kinematics, Dynamics, and Vibrations 15%
III. Materials and Processing 10%
IV. Measurements, Instrumentation, and Controls 10%
V. Thermodynamics and Energy Conversion Processes 15%
VI. Fluid Mechanics and Fluid Machinery 15%
VII. Heat Transfer 10%
VIII. Refrigeration and HVAC 10%

AFTERNOON SESSION IN ELECTRICAL ENGINEERING
(60 questions in 9 topic areas)
Topic Area Approximate Percentage of Test Content

I. Circuits 16%
II. Power 13%
III. Electromagnetism 7%
IV. Control Systems 10%
V. Communications 9%
VI. Signal Processing 8%

VII. Electronics 15%
VIII. Digital Systems 12%
IX. Computer Systems 10%

AFTERNOON SESSION IN INDUSTRIAL ENGINEERING

(60 questions in 8 topic areas)
Topic Area Approximate Percentage of Test Content

I. Engineering Economics 15%
II. Probability and Statistics 15%
III. Modeling and Computation 12%
IV. Industrial Management 10%
V. Manufacturing and Production Systems 13%
VI. Facilities and Logistics 12%
VII. Human Factors, Productivity, Ergonomics, and Work Design 12%
VIII. Quality 11%

AFTERNOON SESSION IN CHEMICAL ENGINEERING

(60 questions in 11 topic areas)
Topic Area Approximate Percentage of Test Content:

I. Chemistry 10%
II. Material/Energy Balances 15%
III. Chemical Engineering Thermodynamics 10%
IV. Fluid Dynamics 10%
V. Heat Transfer 10%
VI. Mass Transfer 10%
VII. Chemical Reaction Engineering 10%
VIII. Process Design and Economic Optimization 10%
IX. Computer Usage in Chemical Engineering 5%
X. Process Control 5%
XI. Safety, Health, and Environmental 5%

4-ETHICS

4.1 Ethics Defined

Ethics is about the good life. The best and most satisfying lifestyle is considered to be of the highest importance.

Ethics includes considerations of moral conduct and the analysis of right and wrong: behavior and social systems. Pollution and weapons of mass destruction raise ethical questions. Another ethical concern is the disparity in technology between first and third world nations.

4.2 Formal Hearings

Each profession: Engineering, Medical, Law, etc. has a written code of ethics. Unfortunately these codes are not always followed. Formal hearings and disciplinary actions are enforced against individuals who deviate from the norm. Here are some examples of engineering code violations:

1. Signing / sealing engineering documents which were prepared by individuals over whom there was no direct supervisory control - $2,000 fine and public reprimand.

2. Minimum standards violation - $1,000 fine and public reprimand.

3. Operating an unlicensed engineering firm - $500 fine and public reprimand.

4. Conflict of interest violation - $500 fine and public reprimand.

4.3 Ethical Priorities

Engineering is challenging work. Providing ground breaking technologies that meet client's needs in a timely manner is often difficult to achieve. A survey of engineering projects showed that 70% exceed the scheduled time and estimated cost. The conflicting demands of engineers profit and client's objectives must be managed fairly.

Public Safety Center, Raleigh North Carolina

Above is the image in its **original context** on the page:

www.godowntownraleigh.com/go/public-safety-center

The following is a list of ethical priorities in order of importance; 1 is highest and 5 lowest.

1. Public safety.

2. Public well-being.

3. Federal, state, and local laws and codes.

4. Clients objectives.

5. Engineers needs.

4.4 Engineers Code of Ethics

Above is the image in its original context **on the page:**
courses.cs.vt.edu/.../lib/WorldCodes/ASCE.html

4.5 Fundamental Ethical Principles

Engineers uphold and advance the integrity, honor and dignity of the engineering profession by:

1. using their knowledge and skill for the enhancement of human welfare;
2. being honest and impartial and serving with fidelity the public, their employers and clients;
3. striving to increase the competence and prestige of the engineering profession; and
4. Supporting the professional and technical societies of their disciplines.

4.6 National Society of Professional Engineers

The National Society of Professional Engineers has published a, “Code of Ethics” directed at the engineering profession. “The members of the profession recognize that their work has a direct and vital impact on the quality of life for all people. Accordingly the services provided by engineers require honesty, impartiality, fairness, and equity, and must be dedicated to the protection of the public health, safety and welfare. … Engineers shall be guided in all their professional relations by the highest standards of integrity. … Engineers shall give credit for engineering work to those to whom credit is due, and will recognize the propriety and interests of others. … Engineers shall cooperate in extending the effectiveness of the profession by interchanging information and experience with other engineers and students, and will endeavor to provide opportunity for the professional development and advancement of engineers under their supervision.”

4.7 Ralph Nader Consumer Activist

From airbags to X-rays, prescription drugs to cigarettes, Ralph Nader's long career as a consumer activist regulated corporate responsibility and redefined consumer rights.

As public interest historian David Bollier explains in AN UNREASONABLE MAN, Nader "approached health and safety regulation as an ethical and social issue. Corporate America redefined it as an economic issue."

Nader and his associates mobilized and invigorated the American consumer activist movement by publicly analyzing and criticizing the corporate and governmental powers behind business decisions. In doing so, Nader helped enact legislative acts including the Clean Air Act, the Freedom of Information Act and the Occupational Safety and Health Act. Nader's leadership and seed money also helped establish consumer organizations such as Congress Watch, the Health Research Group, the Critical Mass Energy Project, the Tax Reform Research Group and the Litigation Group, all of which were eventually combined to form Public Citizen.

Read about these significant legislative acts credited to Nader.

Freedom of Information Act
National Traffic and Motor Vehicle Safety Act
Wholesome Meat Act
Natural Gas Pipeline Safety Act
Clean Air Act
Occupational Safety and Health Act
Consumer Product Safety Act
Safe Water Drinking Act
Clean Water Act
Foreign Corrupt Practices Act
Mine Health and Safety Act
Whistleblower Protection Act

4.8 Freedom of Information Act (1966)

The Freedom of Information Act established the public's right to obtain information from federal government agencies. The Act provides that, upon request from any person, a federal agency must release any agency record unless that record falls within one of the nine statutory exemptions and three exclusions. Examples of requests might include a copy of medical records on yourself or another person.

The Act was amended in 1974, following the Watergate scandal, to increase agency compliance. In 1996, the Electronic Freedom of Information Act Amendments allowed for greater access to electronic information.

4.9 National Traffic and Motor Vehicle Safety Act (1966)

The passage of the National Traffic and Motor Vehicle Safety Act authorized the federal government to set standards for motor vehicles and highways. Resulting changes included mandatory seatbelts and new safety features for cars such as headrests and shatter-resistant windshields. Roads were improved by the installation of guardrails, improved lighting and curves, and new barriers that separated traffic lanes.

The results of the act have been profound. Within four years of its passage, motor-vehicle-related death rates had already decreased. According to the National Center for Statistics, 195,382 lives have been saved by seat belts between 1975 and 2004.

4.10 Wholesome Meat Act (1967)

The Wholesome Meat Act amended the Federal Meat Inspection Act and required U.S. states to conduct more adequate inspections of meat, therefore raising quality standards. Called an "equal to" law, it gave states two years to develop meat inspection programs equally as good as the federal governments. If a state did not do so, the federal system would be applied.

4.11 Natural Gas Pipeline Safety Act (1968)

In 1965, a natural gas pipeline ruptured in Louisiana and killed 17 people, inspiring the enactment of the Natural Gas Pipeline Safety Act. This Act authorized the U.S. Department of Transportation's Pipeline and Hazardous Material Safety Administration, acting through the Office of Pipeline Safety, to regulate safe transportation of natural gas, petroleum and other hazardous materials via pipelines.

4.12 Clean Air Act (1970)

The Clean Air Act regulated air emissions from stationary, mobile and area sources, authorizing the Environmental Protection Agency to establish National Ambient Air Quality Standards (NAAQS) to protect the environment and citizens' health. While the initial goal of the Act was to set and reach NAAQS in all U.S. states by 1975, it was amended in 1977 to set new goals because most states had failed to meet the deadline.

President George H.W. Bush proposed major revisions to the Act in 1989, spurred by a Supreme Court ruling that the Environmental Protection Agency must regulate greenhouse gas emissions from motor vehicles. In 1990, additional amendments were created to address issues including acid rain, greenhouse gas emissions, ozone depletion and air toxins.

4.13 Occupational Safety and Health Act (1970)

The Occupational Safety and Health Act created the Occupational Safety and Health Administration (OSHA), the National Institute of Occupational Safety and Health and the Occupational Safety and Health Review Commission. The Act aimed to protect worker health by ensuring that employers provide workers with an environment free from mechanical dangers, excessive noise, and exposure to toxins and unsanitary conditions. OSHA also prevents work-related injuries and illnesses by enforcing standards on workplace health and safety. The Act extends to most nongovernmental workplaces as well.

OSHA's policies were criticized for their costly regulations. Over time, manufacturers have begun to include OSHA-compliant safety features on new machinery, thus saving companies from having to retrofit equipment. The Reagan and George H.W. Bush administrations both tried to weaken OSHA enforcement and rule making. The George W. Bush administration has since largely replaced mandatory standards with voluntary guidelines, such as repealing a standard for ergonomics and replacing it with guidelines.

4.14 Consumer Product Safety Act (1972)

The Consumer Product Safety Act (1972) established the United States Consumer Product Safety Commission (CPSC) as an independent agency, allowing it to set safety standards and recall or ban products deemed as having unreasonable or substantial safety risks.

In 1994, findings from the CPSC led Congress to pass the Child Safety Protection Act, leading to a decrease in toys with choking hazards. Today, the CPSC has jurisdiction over more than 15,000 types of consumer products and has implemented safety standards on items such as matchbooks, garage door openers and bicycle helmets.

4.15 Safe Water Drinking Act (1974)

The Safe Water Drinking Act protects public health by regulating the public drinking water supply. The

Act authorizes the Environmental Protection Agency to set national standards for drinking water to protect against both naturally occurring and man-made contaminants that may be found in drinking water.

The Act was amended in 1986 and 1996 to further protect drinking water and sources including rivers, lakes, reservoirs, springs and ground water wells.

4.16 Clean Water Act (1977)

The Clean Water Act is the primary federal U.S. law that governs water pollution. It aimed to eliminate the release of highly toxic substances to water and ensure that surface waters in the country would eventually meet necessary standards. Initially created as an amendment to the Federal Water Pollution Control Amendments of 1972, the Clean Water Act established the structure for regulating pollution discharges into U.S. waters and gave the Environmental Protection Agency the authority to implement pollution control programs. The Act also made it illegal to discharge pollutants from a point source into navigable waters without a permit and funded the construction of sewage treatment plants.

In 2007, Wisconsin Senator Russell Feingold introduced the Clean Water Restoration Act, legislation that reiterated Congress's intention to protect all U.S. waters of the United States and its original passage of the Federal Water Pollution Control Amendments. Environmental groups considered this new act necessary to reverse recent repealed protections for the country's waters.

4.17 Foreign Corrupt Practices Act (1977)

The Foreign Corrupt Practices Act was established to prevent corporate bribery of foreign officials. Its major provisions involve accounting transparency requirements and corporate accounts and record keeping. In 1988, the Act was amended to include a “knowing” standard that provided defenses against finding violations.

In 1998, Congress amended the Act to comply with the International Anti-Bribery Act of 1998, which implemented the anti-bribery conventions of the Organization for Economic Co-operation and Development. The new amendments made it unlawful for a U.S. person and certain foreign issuers of securities to make a payment to a foreign official for the purpose of obtaining or retaining business for or with any person.

4.18 Mine Health and Safety Act (1977)

The Federal Mine Safety and Health Act amended the Coal Mine Safety and Health Act of 1969, which required such regulations as two annual inspections of every surface coal mine and four at every underground coal mine in the U.S. It also increased federal enforcement power in coal mines, provided workers' compensation for injured and disabled miners and established criminal penalties for violations of health and safety standards.

The 1977 Act governs the activities of the Mining Enforcement and Safety Administration, which enforces safety and health concerns in the mining industry. Since its passage, U.S. mining fatalities dropped from 272 in 1977 to 86 in 2000.

4.19 Whistleblower Protection Act (1989)

The Whistleblower Protection Act protects federal whistleblowers, or persons who work for the government who report agency misconduct. A federal agency violates the Act if it takes or fails to take action “with respect to any employee or applicant because of any disclosure of information by the employee or applicant that he or she reasonably believes evidences a violation of a law, rule or regulation; gross mismanagement; gross waste of funds; an abuse of authority; or a substantial and specific danger to public health or safety.”

In 2006, the Supreme Court ruled in *Garcetti v. Ceballos* that government employees did not have protection from retaliation by their employers under the First Amendment. In response, the House of

Representatives passed the Whistleblower Protection Act of 2007, which President George W. Bush pledged to veto if Congress enacted it into law, due to “national security concerns.”

Learn about Nader's role as a politician >>

Crusader or Spoiler? Share your opinion of Ralph Nader >>

Read about modern-day consumer advocacy efforts >>

5-CULTURAL DIVERSITY

5.1 Cultural Diversity Defined

Cultural diversity encompasses the cultural differences that exist between people, such as language, dress and traditions, and the way societies organize themselves, their conception of morality and religion, and the way they interact with the environment.

Cultural diversity is tricky to quantify, but a good indication is thought to be a count of the number of languages spoken in a region or in the world as a whole.

Should we Americans learn the languages of foreign companies that locate factories here? Or should workers in the United States who come from other countries be forced to speak and write in English?

© UNESCO / Sayah Msadek UNESCO.ORG
Above is the image in its **original context** on the page: **www.unesco.de/kultur.html?L=1**

5.2 UNESCO

The United Nations Educational, Scientific and Cultural Organization (UNESCO) was founded on 16 November 1945. For this specialized United Nations agency, it is not enough to build classrooms in devastated countries or to publish scientific breakthroughs. Education, Social and Natural Science, Culture and Communication are the means to a far more ambitious goal : to build peace in the minds of men.

Overall, it is formulated around a single unifying theme – UNESCO contributing to peace and human development in an era of globalization through education, the sciences, culture and communication. Thus, it seeks to create a link between UNESCO's mandate and role on the one hand and, on the other, globalization with a human face.

5.2.1 Promoting cultural diversity and intercultural dialogue

Culture counts – this is the message that runs through UNESCO's cultural programme.

Protecting and conserving cultural heritage, preserving and promoting cultural diversity and intercultural dialogue are among its core tasks.

"Protecting the world's heritage of books, artworks and monuments, as well as its history and science, are among the tasks ascribed to UNESCO in its Constitution. Only if humankind knows where it has come from and what has shaped it does it have a well-packed knapsack for the difficult road into the

future."
(Hermann Schäfer, Vice-Chairman of the German Commission for UNESCO)

5.3 Japanese Companies

The comments below are by: S. Honda:

For more link to: http://www.winadvisorygroup.com/WhyWorkforJapaneseCompany.html

Do I need to speak Japanese if I work for a Japanese company in the US?

No, but you do need to be aware of significant cultural differences. Japanese companies in the U.S. continue to place a high value on relationships and keeping those relationships harmonious, where Americans are more competitive and confrontational. In fact, the cultural differences are considerable, but they are readily overcome when you've spent some time learning about them. A good place to start is the book I wrote, *The Sun Also Rises Over Toledo, Practical tips for Americans working with or for Japanese companies in the U.S*. Also, keep your eye on the WIN Web Site. We will regularly add articles having to do with various aspects of working for Japanese-American companies.

The Japanese economy is No. 2 in the world. Despite recent problems, Japan remains a major player in the global community and its investments in the United States have much to offer employees in the way of career growth. Working for a Japanese-owned and –managed company provides a manager with insight into global strategy and international operations.

Are companies owned and managed by Japanese really that different from companies owned and managed by Americans?

Well, in many cases, today's American companies have adopted countless facets of Japanese management style. Leading American companies such as Proctor and Gamble, Hewlett-Packard, Motorola and GM have all implemented versions of the Japanese approach. Management by Walking Around (MBWA) a concept proposed and endorsed by management gurus W. Edwards Deming and Tom Peters is based on Japanese practices.

One distinctive difference that remains, though, is the decision-making process. In many American companies, the decision-making is done at the top, handed down and carried out through the ranks. In a Japanese company you'll find the decision-making process much more participative, with more information-gathering, more analysis and more buy-in before a decision is finalized.

5.4 South Carolina

The author of this course lives and works in South Carolina. The reader is encouraged to research the internet for the new technologies each year in their state.

International companies with operations in South Carolina include: Michelin, Metso Minerals, South Carolina Yutaka Technologies, Margaritelli and Musashi South Carolina.

There are 125 German companies in South Carolina employing 21,975 people. 35 of these companies have their North American Headquarters located here. The companies include: BMW, DAA Draexlmaier, DaimlerChrysler, Robert Bosch, Fehrer, ZF Lemforder, Lang-Mekra.

5.5 The Science of Diversity

The Science of Diversity and Its Relevance in a Fast Changing World

By: Dr. Norman L. Johnson

Ref: http://ishi.lanl.gov/index.html

Biography:

Dr. Norman L. Johnson is currently Deputy Group Leader of the Theoretical Biology and Biophysics group in the Theoretical Division at Los Alamos National Laboratory. Previously, he was Assistant to the Program Manager for Biological Threat Reduction Program Office, under Dr. I. Gary Resnick. He guided the development and execution of a diverse, multi-million chem-bio threat reduction program at Los Alamos over a three year period, in the areas including urban plume modeling, urban surveillance systems, all-threat detectors, material science, BSL-3/BLS-2 facilities, sequence databases, bioinformatics, distributed sensor networks, system studies for the development of technical and operational requirements, forensics, risk assessment, and cost/benefit analysis.

One would think that the role diversity plays in many components of science, from ecology to politics to the stock market, would long ago have been understood. Unfortunately, our social views of diversity are in conflict with our mainstream scientific views. The different roles of diversity are presented within the context of a familiar example (foraging among social insects), and understood within a theory of systems development. This viewpoint may resolve any confusion associated with diversity in organizations. With greater clarification, we may better understand the advantages and disadvantages of diversity in organizations: Does diversity lead to conflict or does it lead to synergy and better solutions? This analysis is timely because of the importance of diversity in decision-making in complex environments, particularly in times of rapid change and particularly post 9/11.

Diversity in the workplace, organization, even nation, has recently become a much touted goal. Our understanding has evolved to recognize that diversity includes more than ethnic variety, but also cultural and educational variety, in fact, any aspect of an individual that leads to a variety of approaches to problems, even personality. Yet, the scientific basis behind the role of diversity in social systems is largely unknown. Research at Los Alamos is providing support for our intuitive understanding of the importance of diversity in social systems.

Much of the past understanding about social diversity is motivated by the analogies to biodiversity in nature. The prevailing research on the role of biological diversity focuses on improvement of system performance (e.g., individual or species survival) by the selection from a pool of genetic diversity, in the process of natural selection or *survival of the fittest*. This process is fundamentally competitive between individuals or groups, with explicit winners and losers. This selection reduces diversity in its application - *diversity is reduced by selection and must be replenished by mutation or migration*. While a similar selection process may occur in social systems, this is neither a compelling justification for diversity within organizations, nor the only mechanism by which diversity contributes to better organizations or society.

Current research at Los Alamos has identified an alternative process for higher system performance, which does not involve competition or cooperation between the individuals, but instead stresses the importance of non-competitive self-organization.

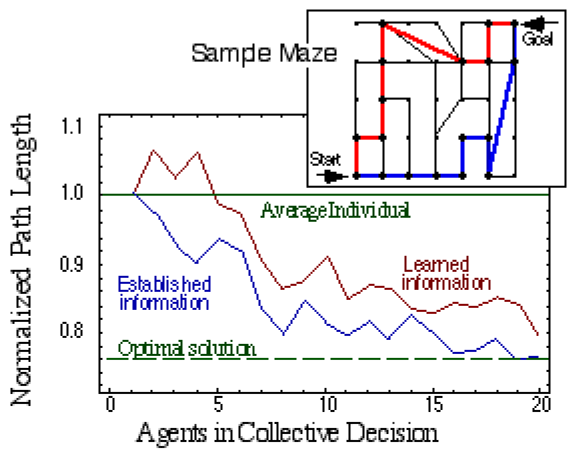


Fig. 1. A sample maze (insert) with two minimum paths highlighted and the simulation results (main figure) showing the effect of the collective size on the path length, normalized by the average individual path length (about 12.8).

5.5.1 Simulating Collective Problem Solving

We wish to address the question: what is the most simple demonstration of increased global performance of a collective above that of the individual? The idealized system examined is the solution of a sequential problem (Insert in Figure 1), which has many optimal and non-optimal solutions, solved by agents that have identical capabilities. While this maze problem is quite simple, it serves as a representation of more complex problems encountered by individuals and organizations: the solution of a problem that has many decisions points and possible solutions and that has difficulty greater than solvable by one individual. Here, agents can represent individuals, groups or organizations within a greater system.

Because the agents have no global sense of the problem, they initially explore the problem until a solution is found. This "learned" information is then applied by the individual agent to solve the problem again, often with a shorter path as a consequence of eliminating unnecessary loops. Because the initial search is random, a collection of individuals shows a diversity of experience (regions of the maze), of preferences (preferred paths), and of performance (path lengths), even though they started with identical capability. (This source of diversity in performance by individuals of identical capability is a reminder how many of the advantages and disadvantages an individual has in social situations are a result of random events and not directly related to our "inherent" capability. Said another way, if we replayed or lived our own lives again, likely it would be quite different due to these random effects.)

Information for a collective of individuals is then constructed by a linear combination of the each individual's experiences. Then the same rules are used on this collective information to find a collective solution. As seen in Figure 1, the collective typically outperforms the average individual for larger collectives. In repeated solutions to a problem, we tend to remember only the information needed to solve a problem and forget extraneous information associated with unused paths. Here, the equivalent effect is for the individual to contribute to the collective only "established" information along paths used by individual, thereby "forgetting" unused paths. Both the *learned* and *established* information produce the same path for the individual agent. As seen in Figure 1, the solution using the established information performs better than the learned information. Furthermore, for collectives above 20, the optimal solution is found, even though nothing in the agent's rules seeks a minimal path length. Figure 2 shows one mechanism for the reason that the collective does better than any individual: individual information can be combined to indicate a shorter path for the collective.

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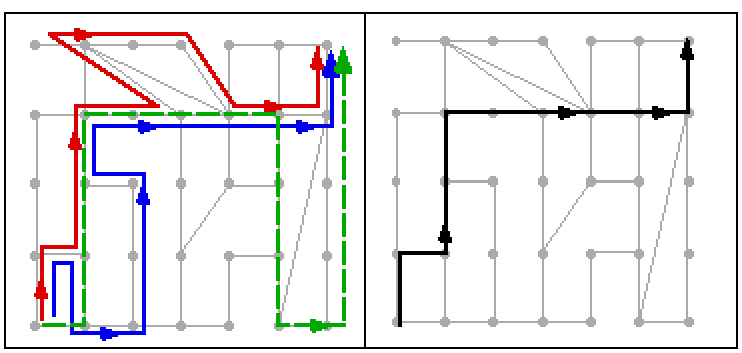

Individual solutions **Collective solution**

Fig. 2. One mechanism for the better performance of the collective. To see how the collective solution is found, pick the path at each node that is traveled by the greatest number of individuals - this corresponds to the maximum preference of the group. Note that the collective path length is better

than any individual.

The organizational equivalent to the mechanism in Fig. 2 is how a group of workers may casually share information about their own experience at a certain point in a decision making process. But because they arrived at a common point from a different path, the relevance of their information may not be apparent and therefore only of value in a casual exchange and not in direct cooperation or competition. In an organization with many casual exchanges, these seemingly random sources of information can be reinforced by a collective exchange and lead either a group of individuals or a single individual to a better overall solution. This improved collective performance, due minimally to the random social exchange of diverse individuals, also benefits the functioning of the whole. It is also easy to see how this same collective effect would not happen with a low diversity group.

5.5.2 Importance of Diversity

To better understand the role and importance of diversity in this simple model and gain insight into social systems, quantitative measures of diversity were examined. The first choice of a measure, the breadth of experience of a collective over all possible paths, was found to be uncorrelated with performance.

The best measure found defines diversity as the degree of unique information in a collection of agents.

If all agents contribute the same information, even if it is for the entire domain, then this measure of diversity is low. If each agent contributes unique information not shared by others, then this diversity measure is high. Consequently, collectives contributing "established" rather than "learned" information exhibit higher diversity, even though less information is contributed by each agent. So we conclude that it is not how much information is important, but how the information contributed fits in to the other information known.

Not only does this measure of diversity correlate best with collective performance, it also indicates the degree of insensitivity to noise. The performance of a collective with low diversity is poor when valid information is randomly replaced with false information, a measure of the robustness of a solution. False information can lead to unexplored paths in a less diverse collective, and then the solution degenerates to a random search (imagine driving and finding yourself on an unfamiliar road - the solution is either to backtrack or to search randomly). Diverse collectives have contingency information that makes the groups highly insensitive to noise. The stabilizing effect of diverse groups is critical in dealing with difficult problems where false information can lead to unexplored paths. In research which focuses on rational individuals with perfect information, an evaluation of performance often does not consider the robustness to noise, hence, the reason that diversity is rarely considered important. Yet, robustness is a critical aspect of any modern organization.

If the effect of information exchange between individuals (a form of cooperation) is included in the above simulations, such that the individual while learning the maze can benefit from other agent's experiences, we find that improved individual performance can be achieved. But if the outside information is used too strongly, then there is the ultimate loss of diversity in the collective as every individual has the identical experience. In this case, the robustness of the collective can be severely degraded if the positive feedback or coherence is too great. We conclude that cooperation is actually a form of selection and reduces the expression of diversity (if I cooperate with you consistently, then I don't cooperate with someone else). It is easy to see that the random associations that are beneficial to the group and individual above can be reinforced to the point of being exclusive. While this leads to more optimal performance, it also causes the groups to be less robust. (To see how this transition is part of a bigger view of how systems develop, see the paper titled *Developmental Insights into Evolving Systems: Roles of Diversity, Non-Selection, Self-Organization, Symbiosis* on the documents page.)

5.5.3 Social and Organizational Implications

The above study illustrates how diversity can arise with agents of identical capability from experiential differences within a system which contains multiple options. Just the existence of random options in the problem domain creates diversity. This is in contrast to the standard ecological arguments that diversity originates from competition to fill new niches. It is believed that this generation of random options and traits are a direct consequence of the system becoming more complex, a natural consequence of the development cycle of evolving systems (see the paper titled *Developmental Insights into Evolving Systems: Roles of Diversity, Non-Selection, Self-Organization, Symbiosis* on the documents page.)

Furthermore, higher system performance and robustness occurs by the simple combination of the experiences of individuals, even though each individual solves a problem from a limited perspective. Unlike the selections view of diversity in natural systems, this study indicates that even in the absence of direct competition between and the consequential selection of individuals, a higher system performance can be achieved with an alternative mechanism: the non-competitive combination of information from a diversity of individuals. In fact, the idealized system exhibits lower performance or lower stability if any selection is made, either by eliminating participation or reducing their contribution. In some cases, it is even found that eliminating the contributions of the higher performers actually can improve the group solution!

The simulations also illustrate that improved collective performance can only be achieved with minimally skilled (or better) agents. If the agents gain experience randomly (have no "skill"), the collective shows no improvement over the average individual. We conclude that the performance of the whole is tied to the performance of the individual - as the individual learns, the non-competitive combination of diverse experiences increases the performance of the system as a whole.

These results argue for the importance of organizational environment that freely exchanges information for both the benefit of the individual, but also for the group or organization. Many economic and social models of human dynamics begin with the assumption of competitive agents seeking limited resources. Furthermore, they embody significant capability in their agents to explain higher global performance. In the simple model above, system performance is shown to be greater than the capability of the agents and to occur from essentially independent agents randomly sharing information. Mechanisms of competition or cooperation are not required. The results also show that if the collective dominates the learning of the individual, and thereby reduces the diversity, then group performance become less robust.

In modern times of organizations becoming more complex and facing problems of greater difficulty, centrally directed management of expert resources may not be an optimal approach to problem solving. For organizations to take advantage of increased performance from diversity, these studies suggest that, in addition to a skilled and diverse workforce, it is also necessary to encourage the expression of diverse views and to enable mechanisms for the exchange and processing of these views. The implications for all organizations is to create a work environment in which all employees are willing and able to contribute their knowledge and experience to solving the problems facing these organizations.

Learn more at the Full diversity site

6-ENVIRONMENT

6.1 The Natural Environment

The natural environment was pristine. Earth, water, and air were pure and unpolluted. However this condition is changing.

www.theebdgroup.com/Environment.asp

Some new technologies do as much harm as good, creating huge new challenges for the world: consider the motor vehicle, which symbolizes gridlock and pollution at least as much as it does freedom and affluence.

wfrc.org/cms/index.php?option=com_content...

A Crowded Freeway above

6.2 Ozone Pollution

Most ozone pollution is caused by motor vehicles, which account for 72% of nitrogen oxides and

52% of reactive hydrocarbons (principal components of smog). (30 Simple Energy Things You Can Do to Save the Earth. Los Angeles: South California Edison, 1990, p. 11.,)

Emissions from cars dwarfs that from power plants. In May 2000, Austin Energy planned to reduce nitrogen oxide (NOx) emissions by 40% at its Decker and Holly power plants, from 1700 tons per year to less than 1000tpy by 2003. By comparison, NOx emissions in Travis county from motor vehicles totaled approximately 30,000 tons per year in 1996 -- the last year for which complete data was available. (Austin Energy brochure, 2000)

SUV's put out 43% more global-warming pollutants (28 pounds of carbon dioxide per gallon of gas consumed) **and 47% more air pollution than the average car.** (4, cited in 2002)

byoost.blogspot.com/2007/06/ciudad-de-mexico.html

6.3 Smog

Smog in Los Angeles due in part to motor vehicles is pictured above.

Los Angeles is the largest city in the state of California and the second-largest in the United States. Often abbreviated as **L.A.**, it is rated an alpha world city, having an estimated population of 3.8 million and spanning over 469.1 square miles (1,214.9 square kilometers) in Southern California. Additionally, the Greater Los Angeles metropolitan area is home to nearly 17,776,000 people who hail from all over the globe and speak more than a hundred different languages.

6.3.1 Primary pollutants in LA smog:

- CO - carbon monoxide
- NO - nitric oxide
- ROG - reactive organic gases (unburned gasoline)
- These are mainly direct combustion products from gasoline- or diesel-burning internal combustion engines.
- There is a significant source of ROGs from stationary industries and small businesses.

Another major source of pollution is industrial and chemical manufacturing plants.

public.globalnet.hr/~gvlahovi/ekologija/ecolo...

6.3.2 Industrial Pollution

Toxic chemicals are exhausted through chimneys into the atmosphere. The waste from industries are directly dumped into surrounding water bodies and open lands which causes various types of pollution. This is known as industrial pollution.

6.4 National Ambient Air Quality Standards (NAAQS)

The Clean Air Act, which was last amended in 1990, requires the EPA to set **National Ambient Air Quality Standards** (40 CFR part 50) for pollutants considered harmful to public health and the environment. The Clean Air Act established two types of national air quality standards. ***Primary standards*** set limits to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly. ***Secondary standards*** set limits to protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings.

The EPA Office of Air Quality Planning and Standards (OAQPS) has set National Ambient Air Quality Standards for six principal pollutants, which are called "criteria" pollutants. They are listed below. Units of measure for the standards are parts per million (ppm) by volume, milligrams per cubic meter of air (mg/m^3), and micrograms per cubic meter of air ($\mu g/m^3$).

National Ambient Air Quality Standards

	Primary Standards		Secondary Standards	
Pollutant	**Level**	**Averaging Time**	**Level**	**Averaging Time**
Carbon Monoxide	9 ppm (10 mg/m^3)	8-hour[(1)]	None	
	35 ppm (40 mg/m^3)	1-hour[(1)]		
Lead	1.5 $\mu g/m^3$	Quarterly Average	Same as Primary	
Nitrogen Dioxide	0.053 ppm (100 $\mu g/m^3$)	Annual (Arithmetic Mean)	Same as Primary	
Particulate Matter (PM_{10})	150 $\mu g/m^3$	24-hour[(2)]	Same as Primary	
Particulate Matter ($PM_{2.5}$)	15.0 $\mu g/m^3$	Annual[(3)] (Arithmetic Mean)	Same as Primary	
	35 $\mu g/m^3$	24-hour[(4)]	Same as Primary	
Ozone	0.075 ppm (2008 std)	8-hour[(5)]	Same as Primary	
	0.08 ppm (1997 std)	8-hour[(6)]	Same as Primary	
	0.12 ppm	1-hour[(7)] (Applies only in limited areas)	Same as Primary	
Sulfur Dioxide	0.03 ppm	Annual (Arithmetic Mean)	0.5 ppm (1300 $\mu g/m^3$)	3-hour[(1)]
	0.14 ppm	24-hour[(1)]		

By Juliet Eilperin
Washington Post Staff Writer

Thursday, March 13, 2008; Page A01

The Environmental Protection Agency yesterday limited the allowable amount of pollution-forming ozone in the air to 75 parts per billion, a level significantly higher than what the agency's scientific advisers had urged for this key component of unhealthy air pollution.

6.5 The Environmental Protection Agency, EPA

Information about the EPA may be obtained from:
http://www.epa.gov/newsroom/newsreleases.htm

Are all environmental issues the responsibility of the EPA?

No, some issues are primarily concerns of other federal, tribal, state or local agencies. EPA also works in partnership with state environmental agencies. Many environmental programs have been delegated to the states and they have primary responsibility for them. Often, it is most appropriate to

contact your local (city or county) or state environmental or health agency rather than EPA.

6.5.1 Examples of different situations and who to call include:

The Endangered Species Act is primarily managed by the U.S. Fish and Wildlife Service. EPA's concern with this act is assuring that the use of pesticides does not endanger these species.

Many **wildlife** concerns are **connected with destruction of wetlands**. The U.S. Army Corps of Engineers determines whether an area is a wetland and issues permits for use of such an area. The permit applications are reviewed by the U.S. Environmental Protection Agency under Section 404 of the Clean Water Act. Therefore, initial contact should be made with your nearest Army Corps of Engineers' office. To get the phone number of your local district office, phone 1-800-832-7828 or visit their website at the above link. [You may also visit the Wetlands Oceans and Watersheds Web area for more information about what defines a wetlands.]

For concerns about wildlife such as foxes, birds, prairie dogs, rabbits, etc. that are caused by development and other human encroachment, contact your **state or local wildlife office**.

Problems with the environment **inside the workplace**, such as presence or handling of chemicals or noxious fumes, are under the jurisdiction of the Occupational Safety and Health Administration, an arm of the U.S. Department of Labor.

The Consumer Product Safety Commission **is the office that deals with the safety of products used in daily life**. They have information on formaldehyde in mobile homes, fiberglass in insulation and other building materials, the safety of all terrain vehicles, and equipment used for children's safety. The toll free phone number is 1-800-638-2772. This commission is arm of the U.S. Department of Health and Human Services.

The Food and Drug Administration and EPA have a cooperative arrangement with regard to the Federal Insecticide, Fungicide and Rodenticide Act. FDA is responsible for the safety of food and any substance that is applied to the human body. EPA is responsible for the safe use of pesticides in controlling insects, rodents, fungus, and sanitizers that are used on surfaces. [Licensing of commercial and private pesticide applicators may be handled by state Departments of Agriculture or EPA. You would need to contact your Regional EPA Office for more information.]

Information on gardening or farming in your area is best obtained from your **local Agricultural Extension office**, which can be listed in your local telephone directory under your county offices or your state university listing.

Noise complaints. EPA no longer regulates most types of noise pollution. You should consult with your local governmental (e.g., city and county) authorities to see if there are local or state laws that might apply to your situation. View more information about resources on noise pollution in the following Frequently Asked Question:

Title: Does the EPA regulate noise? Where are there resources about noise pollution?
URL: http://publicaccess.custhelp.com/cgi-bin/publicaccess.cfg/php/enduser/std_adp.php?p_faqid=1765

Dust on Roads is a local issue. You should contact the **local environmental or health agency**.

Questions about your local landfill. You should contact your **county environmental agency**.

(This information was derived from the Region 8 FAQ page at: http://www.epa.gov/region08/about/faqsr8.html)

7-GLOBALIZATION

7.1 Globalization Data Links

The United States and Japan give more aid in absolute terms, to developing countries than other nations.

Globalization data is available from official sources such as the United Nations, the World Bank, the Organisation for Economic Co-operation and Development (OECD), and the United Nations, or from academic researchers.

Above is the image in its **original context** on the page: **www.nbr.org/.../global_articles.aspx**

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7.2 National Bureau of Asian Research NBR

Our Mission

The National Bureau of Asian Research is a nonprofit, nonpartisan research institution dedicated to *informing and strengthening policy in the Asia-Pacific*.

NBR conducts advanced independent research on strategic, political, economic, globalization, health, and energy issues affecting U.S. relations with Asia. Drawing upon an extensive network of the world's leading specialists and leveraging the latest technology, NBR bridges the academic, business, and policy arenas.

The institution disseminates its research through briefings, publications, conferences, Congressional testimony, and email forums, and by collaborating with leading institutions worldwide. NBR also provides exceptional internship opportunities to graduate and undergraduate students for the purposes of attracting and training the next generation of Asia specialists.

Above is the image in its **original context** on the page: **www.fortunewatch.com/.../**World Bank

7.3 The World Bank

The World Bank is a vital source of financial and technical assistance to developing countries around the world. We are not a bank in the common sense. We are made up of two unique development institutions owned by 185 member countries—the International Bank for Reconstruction and Development (IBRD) and the International Development Association (IDA).

Each institution plays a different but supportive role in our mission of global poverty reduction and the improvement of living standards. The IBRD focuses on middle income and creditworthy poor countries, while IDA focuses on the poorest countries in the world. Together we provide low-interest loans, interest-free credit and grants to developing countries for education, health, infrastructure, communications and many other purposes.

7.3.1 Financial & Private Sector Development

The joint World Bank-IFC Financial and Private Sector Development Vice Presidency focuses on three core areas:

- Creating the institutional foundations for effective markets (examples: property rights, collateral systems, corporate governance, financial market infrastructure)
- Promoting open and competitive markets (examples: opening up entry, access to finance for promising firms, deeper and more liquid financial markets, and exit for failing firms)
- Supporting social safety nets with market-based instruments (examples: financial market-based instruments and risk management for pensions and insurance systems as well as low income housing)

This work contributes to:

- **Job and wealth creation**

  Productive jobs tend to be created in private markets; competition tends to drive upgrading of skills and productivity growth, especially when backed by deeper and more liquid financial systems; in turn this raises real wages.

- **Opportunity for all**

  Rules-based markets that allow entry of new firms promote success on the basis of rules, not on the basis of personal connections; this stimulates movement from the informal to the formal sector including access to finance for underserved small firms and households.

- **Better governance**

  Better regulation reduces opportunities for corruption; wealth creation and entry of new parties into the market tend to create demand for better governance; corporate governance and anti-money laundering activities directly provide greater transparency and remedies against abuse.

Major Topic Areas:

Agriculture & Rural Development
Commodity Risk Management, Forests, Land Policy …

AIDS
Africa, South Asia, AIDS

Law & Development
Environmental, Insolvency, Law & Justice Institutions …

Macroeconomics & Growth
Monetary Policy, Fiscal Policy …

Economics …

Anti-Corruption
Strategy, Investigations, Projects …

Avian Flu
East Asia, Economic and Social Impacts, Outbreak Maps …

Children & Youth
Strategy, Goals …

Debt Issues
HIPC, Debt Relief, Debt Sustainability …

Education
Early Childhood, Girls, Secondary & Tertiary …

Energy
Oil & Gas, Markets & Reform …

Environment
Biodiversity, Climate Change, Drylands …

Evaluation Monitoring
Quality Enhancement …

Faiths and Development
Fostering dialogue on a range of value and ethically-related issues …

Financial Sector
Banking Systems, Capital Markets, Payment Systems …

Gender
Strategy Paper, Stats …

Globalization
Definitions, Poverty …

Global Monitoring
Development Goals, policies …

Health, Nutrition & Population
Malaria, Safe Motherhood …

Information & Communication Technologies

Millennium Development Goals
Poverty, Education, Gender Equality, Child Mortality …

Mining
Environment, Closure …

Participation
Community Driven Development …

Policies
Safeguard Policies, Fiduciary Policies, Disclosure …

Poverty
Inequality, PRSP …

Private Sector Development
Corporate Governance, Investment Climate, Privatization …

Public Sector Governance
Decentralization, Tax Policy …

Social Development
Social Safeguard Policies, Conflict Prevention …

Social Protection & Labor
Child Labor, Pensions, Safety Nets …

Sustainable Development
Infrastructure, Environment, Agriculture, Social Dev't …

Trade
Competition, Standards …

Transport
Ports & Logistics, Railways, Roads …

Tsunami
Natural Disasters …

Urban Development
Disaster Management, Municipal Finance …

Water Resources Management
Dams, Watershed Management …

Internet, Telecommunications …

Knowledge Sharing
Capturing, Organizing, Sharing …

Water Supply & Sanitation
Efficiency, Finance, Regulation …

7.4 Global South Carolina

The author of this course lives and works in South Carolina. The reader is encouraged to research the internet for the many new technologies in their state each year.

South Carolina Leads the Nation in Job Attracting Foreign Investment

Foreign companies support nearly 8.4 percent of private sector jobs

Columbia, SC – According to the Organization for International Investment, the Palmetto State ranks first in the nation in the share of its private sector workforce supported by U.S. subsidiaries of companies headquartered abroad. Direct foreign investment employment accounts for some 127,500 jobs in South Carolina, or 8.4 percent of its private industry employment.

“Making the business climate more attractive for investment is part of our ongoing economic development strategy to create jobs and raise income levels for South Carolinians,” said Gov. Mark Sanford. “Working with the Department of Commerce, we’re going to keep working to accelerate the pace of growth in our economy by continuing to attract investment and jobs from companies at home and abroad to South Carolina.”

Direct foreign investment jobs in South Carolina grew by more than 10,000 jobs during the past five years, for an increase of nine percent. And 51% of these jobs are in the manufacturing sector, for a total of 64,900 employees. In fact, one out of 12 private sector jobs can be attributed to foreign companies with South Carolina operations.

“As the globalization of the marketplace continues, we remain committed to pursuing direct foreign investment, especially targeting those companies in our competitive clusters to diversify our state’s economy and enhance the quality of lives for all South Carolinians,” said Secretary of Commerce Bob Faith. “That’s why we have invested resources in our three foreign offices. And we will continue to meet with chief executives from the world’s leading companies to show them why South Carolina is a great place to do business.”

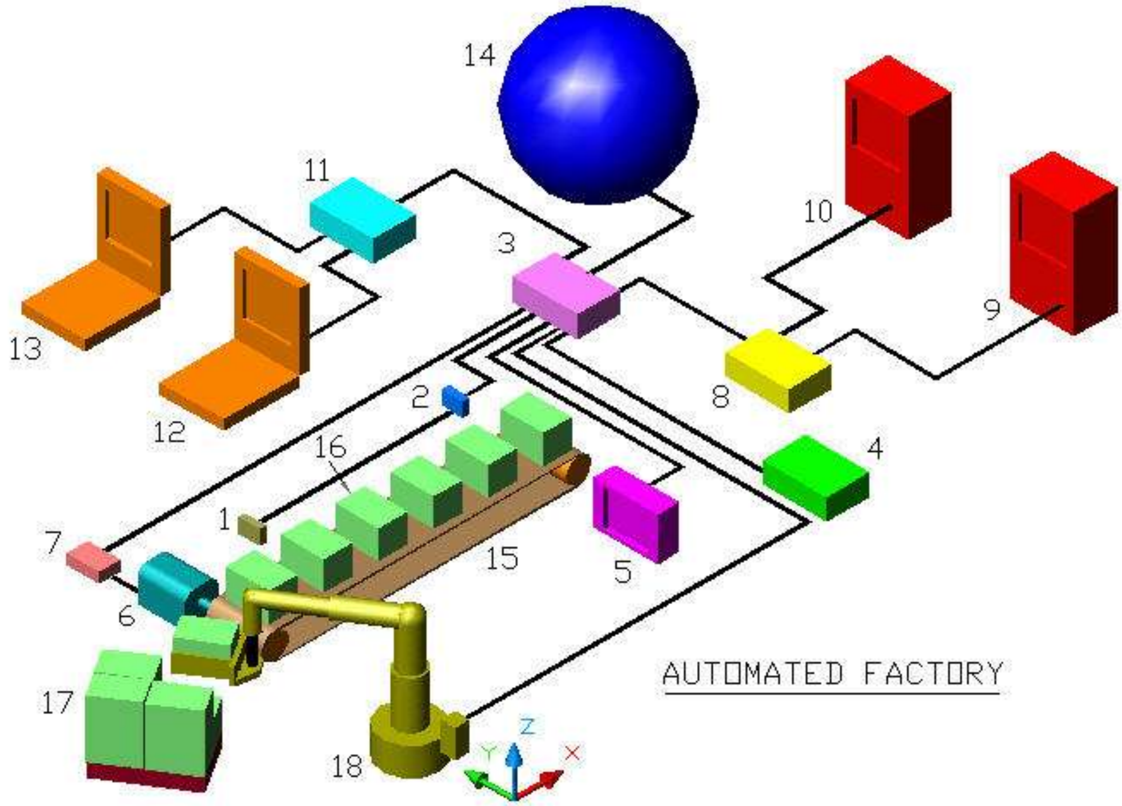
The South Carolina Department of Commerce has international offices in Munich, Germany; Tokyo, Japan; and the recently-opened office in Shanghai, China.

There are 604 foreign companies operating in South Carolina. Of those, German, French and Japanese-owned affiliates account for most of the foreign-affiliated manufacturing employment in the state. In recent months, international companies announcing new or expanding operations in South Carolina included Michelin, Metso Minerals, DaimlerChrysler, South Carolina Yutaka Technologies, Margaritelli and Musashi South Carolina.

The source of these figures is the U.S. Department of Commerce’s Bureau of Economic Analysis.

7.5 Today’s Automated Factory is Controlled Globally

The automated factory illustrated below transmits every detail of its operations to the world wide web, item 14.



7.5.1 Elements of an automated manufacturing system, above.

1. Laser sensor indicates part is present.
2. Bar code reader.
3. Gateway router.
4. Programmable Logic Computer (PLC).
5. Human-Machine-Interface (HMI).
6. Direct current stepper motor conveyor drive.
7. Variable: angle / speed, controller.
8. Hub to servers.
9. Sever.
10. Back-up Server.
11. Hub to laptops.
12. Laptop.
13. Laptop.
14. World Wide Web.
15. Belt conveyor.
16. Finished product.
17. Packaging for shipment.

Over one-fourth (26.4 percent) of all manufacturing workers in South Carolina depend on exports for their jobs, tied with Massachusetts for the third highest figure among the 50 states. (2005 data are the latest available.)

Related PDH Courses

G186 Inventing by the NCMR Method
G235 Applying for a Patent Online
M237 Automation and Robots

This is the end of "Technology in Society".