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Role of Physics Education in Sustainable Development of Technology

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ABSTRACT : *Physics is the study of natural science such as matter & energy. It plays an important role in the development of technology. In machine technology, there are various basic principles of physics such as thermodynamics, mechanics, kinematics, material science which are applied for its development. Also physics plays important role to develop machines such as refrigeration and air-conditioner, power tools, and other power-using machines. In electrical technology the study of electricity was largely considered to be a subfield of physics. Power engineering deals with the generation, transmission and distribution of electricity as well as the design of a range of related devices. Development of electronics, telecommunication and instrumentation techniques is an off spring of the basic science physics. Communication, which has brought the world closer, has been developed from different ways of communication such as telephone, fax, cell-phone, and the Internet for which physics scientist put tremendous efforts. Civil engineering deals with the design, construction and maintenance of the physical and naturally built environment. In computer technology physicists put applications like CD writing, Laser printing, Fiber Optics data transfer system .While the growing area of application is computational physics, which includes electronic structure calculation, statistical physics, atomic theory, and computer simulation of physical phenomena. Development of nanotechnology & superconductors theory is the commanding area of the physicist. Their efforts are to put these techniques in the development of humanity.Physics plays a key role to hold the nature and technology together. The article puts an overview to minimize the valley created among the technologist and the scientist.*

I. INTRODUCTION

The universe is a composition of matter and energy. Existence of universe is due to infinite number of interactions of matter and energy. These interactions are studied under a special branch of science and technology called as physics. Since human being has to come across various parts of energy, physics has become a part of his life. Therefore it is a subject of interest not only for students but also of society. Physics also plays primary role in all professional disciplines of technology v.i.z. engineering, since engineering has been the offspring of physics. Physics covers a wide range of phenomena, from elementary particles such as quarks, neutrinos and electrons to the largest super clusters of galaxies. Physics also aims to describe the various phenomenons that occur in nature, in terms of simpler phenomena. [1]

Different branches of physics play an important role in the development of technology to bring comfort to the human lifestyle v.i.z. statics, a subfield of mechanics, is used in the building of bridges and other civil structures. The understanding and use of acoustics, results in better concert halls. The use of optics creates better optical devices. An understanding of physics makes realistic flight simulators, video games, and movies, and is often critical in forensic investigations.

Now a day a huge gap between technologist and basic research physicist is observed. That deprives the technologists from nature, environment and also the affinity towards social cause. This approach harms the basic concept of development of technology. Hence to keep intact eco system; it is highly essential that technologist should have basic understanding about the concepts of the natural sciences. The article will keep one step forward in the direction of building bridge between physical science and technology.[4]

II. ROLE OF PHYSICS IN VARIOUS BRANCHES OF TECHNOLOGY

Technology is the discipline, art and profession of acquiring and applying scientific, mathematical, economical, social, and practical knowledge to design and build structures, machines, devices, systems, materials and processes that safely realize solutions to the needs of society.

The sciences of physics, chemistry, biology and mathematics are often used by technologist to find suitable solution of problems or to make improvements in it. Technologists are now required to have knowledge of relevant sciences for their design projects along with learning of new materials throughout their career. Among all the offspring's of science physics is renowned as science of technology.

2.1 Various branches of Physics

Physics plays an important role in all this various branches of technology, such as, machine technology, electrical technology, electronics, civil etc. Even, there are different branches of physics which also plays important role in technology. The various branches of physics which are closely associated with the technology are shown in Fig.1[4].

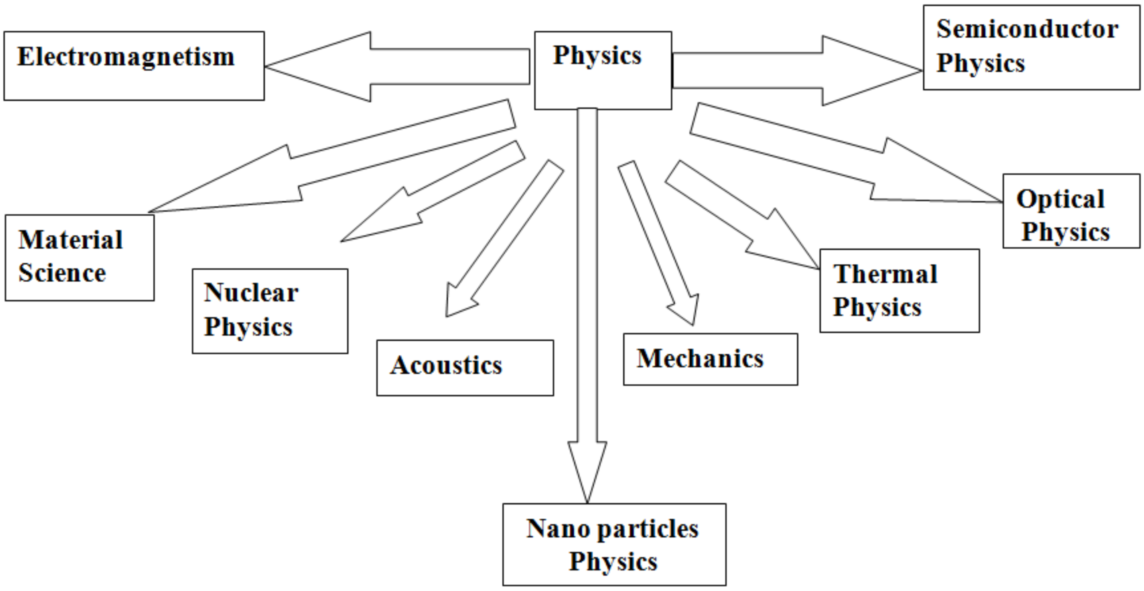

Fig. 1 Flowchart showing subfields of physics

2.1.1 Electromagnetism

Electromagnetism is the study of electricity and magnetism, which is studied in classical physics, both in motion and at rest. The subdivisions of this branch include magneto statics, the study of magnetic poles at rest, electrostatics (or the study of electric charges at rest), and electrodynamics (or the study of electric charges in motion).

2.1.2 Material Science

Material science is the science of study of all natural and chemically synthesized materials to achieve specific property. It is used in mechanics to choose appropriate materials for the frame and engine & to design a ventilation system for the vehicle. It is also used to design the intake system composite materials or a combination of materials which provide different physical characteristics than either material separately.

2.1.3 Acoustics

The Greek word Acoustics means 'to hear'. The study of sound generation, propogation and sensation is done in this branch. It is classical physics branch of sound studies and sound vibrations. The study of acoustics involves how sound travels in waves and through specific media[4].

2.1.4 Physics of Nanoparticles

Richard Feynman in 1959, in his speech expressed that 'Why not mimic nature & Produce smaller and smaller functional materials, which will be highly efficient' and today we are getting advantages of various small sized gadgets. This causes us to work with small sized particles.

The particles sized in the range of billionth of meter are known as nanoparticles. The research and application of the nanostructure particles is called as nanotechnology. An atom or small molecule in the form of vapor is smaller in size than in nanometer. But, as they are in gaseous form and their molecules are not in arranged manner, they are not in category of nanotechnology.

2.1.5 Mechanics

Mechanics, a division of classical physics, explores bodies in motion and the forces that act upon them. The subdivisions of mechanics include the study of motion and the forces related to it, called "dynamics," the study of bodies at rest, called "statics," and the study of bodies in motion without being concerned with the forces causing that motion, known as "kinematics."

Quantum Mechanics

Quantum mechanics, a division of modern physics, investigates properties of matter at the microscopic level. This branch of physics includes atomic physics, molecular physics, nuclear physics, particle physics, condensed matter physics and nanophysics

2.1.6 Thermodynamics

The four regulations of thermodynamics determine fundamental physical volumes (temperature, energy, and entropy) that determine thermodynamic systems. The regulations explain how these volumes behave under various circumstances, and prohibit certain phenomena (such as everlasting motion).

The four chief laws of thermodynamics are as:

Zeros law of thermodynamics in physics:

If two techniques are in heat stability with a third program, they must be in heat stability with each other. This law allows to determine the view of heat range.

First law of thermodynamics in physics:

Warm is a way of power. Because power is maintained, the inner power of a system changes as temperature runs in or out of it. Equivalently, everlasting movement models of the first type are difficult.

Second law of thermodynamics in physics:

The entropy of any shut program not in heat stability almost always rises. Equivalently, everlasting movement models of the second type are impossible.

Third law of thermodynamics in physics:

The entropy of program techniques a continuous value as the heat range techniques zero. The entropy of a program at total zero is generally zero, and in all situations is established only by the variety of different floor declares it has.

2.1.7 Optics

The study of optics in classical physics explores the properties of light, from its visible spectrum to ultraviolet and infrared radiation. Polarization of light, one of the optics concepts is used in manufacturing of latest television type known as LCD. In computer , CD writing , Laser printing are the applications of holographic technique of the optics. [3]

2.2 Physics in Machine Technology Development

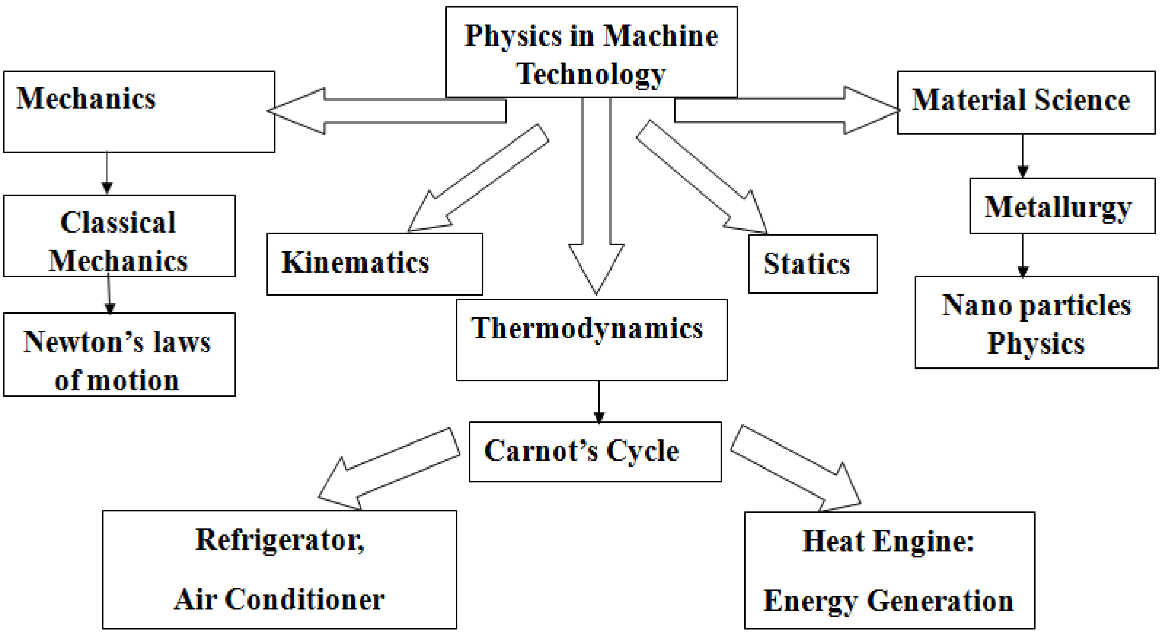

Fig. 2 Flowchart showing physics in machine technology

The offspring's of physics used in machine technology have been shown in Fig. 2. A mechanical engineer designs the tools and processes used for satisfying the needs of society through a combination of material, human, and economic resources. He might work on electric generators, internal combustion engines, steam and gas turbines, and other power-generating machines. He might also develop machines such as refrigeration and air-conditioning equipment, power tools, and other power-using machines.

2.2.1 Mechanics

Mechanics is the study of forces and their effect upon matter. Typically, engineering mechanics is used to analyze and predict the acceleration and deformation (both elastic and plastic) of objects under known forces (also called loads) or stresses. Sub disciplines of mechanics include Statistical Mechanic, Classical Mechanics and Quantum Mechanics.

2.2.2 Kinematics

Kinematics is the study of the motion of objects and groups of objects, while ignoring the forces that cause the motion. The movement of a crane and the oscillations of a piston in an engine are both simple kinematic systems. The crane is a type of open kinematic chain, while the piston is part of a closed four-bar linkage.

Mechanical engineers typically use kinematics in the design and analysis of mechanisms. Kinematics can be used to find the possible range of motion for a given mechanism, or, working in reverse, can be used to design a mechanism that has a desired range of motion.

2.2.3 Thermodynamics

It is an applied science. Thermodynamics is the study of energy, its use and transformation through a system.

Engineering thermodynamics is concerned with changing energy from one form to another. E.g. automotive engines convert chemical energy from the fuel into heat, and then into mechanical work that eventually turns the wheels.

Thermodynamics principles are used by mechanical engineers in the fields of heat transfer, thermo fluids, and energy conversion. Mechanical engineers use thermo-science to design engines and power plants, heating, ventilation, and air-conditioning (HVAC) systems, heat exchangers, heat sinks, radiators, refrigeration, insulation.

2.2.4 Material Science

Material science is used in mechanics to choose appropriate materials for the frame and engine & to design a ventilation system for the vehicle or to design the intake system Composite materials are a combination of materials which provide different physical characteristics than either material separately.

Composite material research within mechanical engineering typically focuses on designing stronger or more rigid materials while attempting to reduce weight, susceptibility to corrosion, and other undesirable factors. Carbon fiber reinforced composites, for instance, have been used in such diverse applications as spacecraft and fishing rods [3, 5].

2.3 Physics in Electrical Technology Development

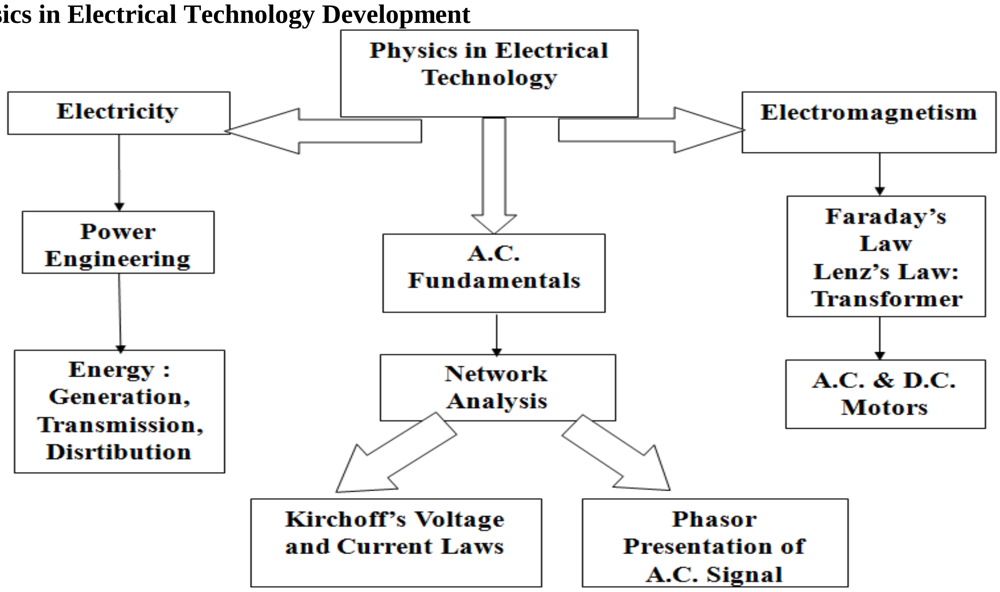

Fig. 3 Flowchart showing physics in electrical technology.

The study of electricity was largely considered to be a subfield of physics as shown in Fig.3. Georg Ohm, in 1827 quantified the relationship between the electric current and potential difference in a conductor. The following chart explains relation between Electrical Technology and fundamentals of physics.

2.3.1 Basics of Electrical Engineering

Michael Faraday, the discoverer of electromagnetic induction in 1831, and James Clerk Maxwell, who in 1873 published a unified theory of electricity and magnetism in his treatise Electricity and Magnetism. Thomas Edison built the world's first large-scale electrical supply network.

2.3.2 Power Engineering

It deals with the generation, transmission and distribution of electricity as well as the design of a range of related devices. These include transformers, electric generators, electric motors, high voltage engineering and power electronics.

In many regions of the world, governments maintain an electrical network called a power grid that connects a variety of generators together with users of their energy.

This field also includes conventional and non conventional sources of energy. Physicist and chemists are working hard to develop efficient and economically desirable sources of non conventional energy.[5]

2.4 Physics in Development of Electronics and Telecommunication Techniques

Today's communication industry is a leading force in the world's economy. Our lives would be vastly different without the telephone, fax, cell-phone, and the Internet. The common place and ubiquitous nature of this technology, which has been evolving over a period of 125 Years. Fig. 4 shows offspring's of physics in electronics and telecommunication technology.

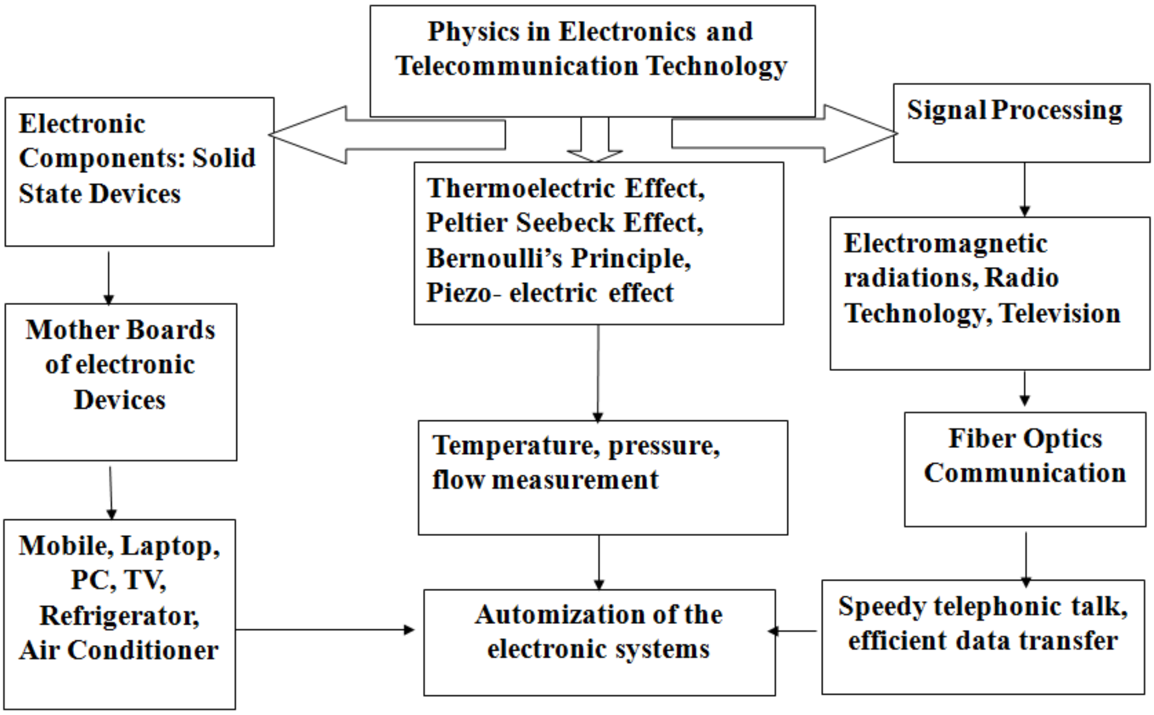

Fig. 4 Flowchart of physics offspring's in electronics and telecommunication technology.

2.4.1 Physics in Communication Technology

Communications industry has not only made use of the results of academic physics research but has also contributed significantly to our present understanding of fundamental physics.

There is critical impact of the four major areas of physics on the communications to made drastic improvements in communications technology, with demonstrable benefits to society. All these four major areas of physics i.e. electromagnetism, the electron theory, quantum mechanics, quantum optics, includes the fundamental discoveries. These discoveries were applied by the communications industry in recent 15-20 years. There are clear indications that the present international telecommunications system will be replaced within ten years by a network mainly based on glass fibers. It is expected that the new world wide Broadband Integrated Services Digital Network (B-ISDN) will allow bit rates of up to 150 M bit/s for communication 'up to your office' at a price per second which is not higher than we pay now for our everyday telephone calls.

This means that the communication between, e.g., physicists of the next generation will no longer be hindered by distance, lack of capacity and costs; the text of a publication available anywhere in the world in a well ordered database can be selected and transmitted to every pc or workstation in the world in less than a minute and at almost no transmission cost.[5]

2.5 Physics in Civil Work

Civil engineering is a professional engineering discipline that deals with the design, construction, and maintenance of the physical and naturally built environment, including works like roads, bridges, canals, dams, and buildings. Fig. 5 shows how physics works for civil professionals.

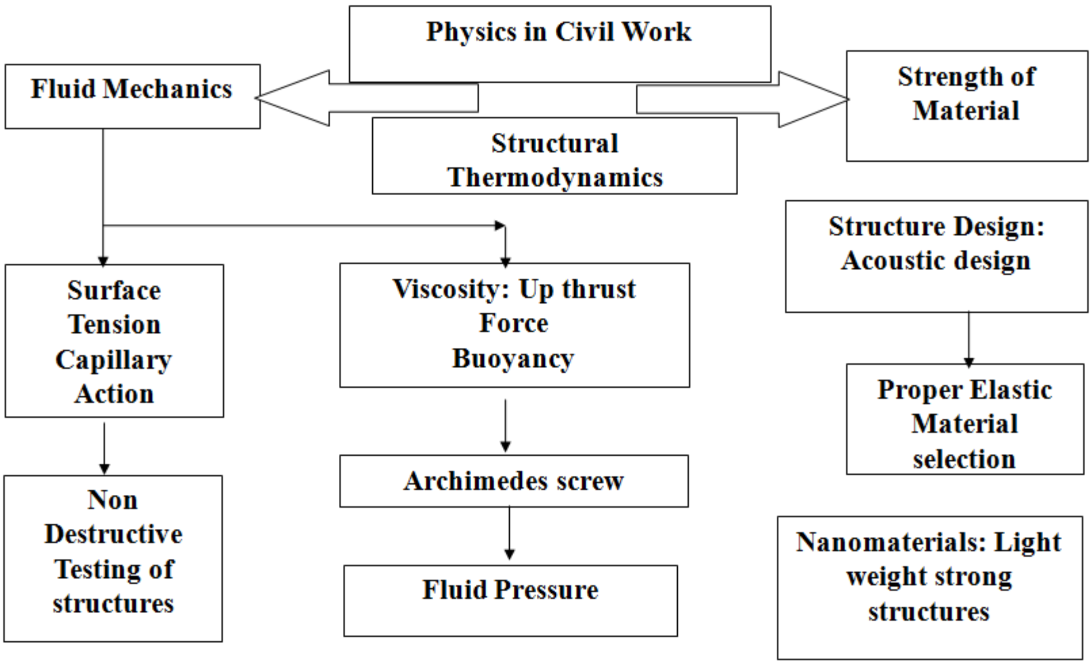

Fig. 5 Flowchart showing physics in civil engineering.

Civil engineering is the oldest engineering discipline, and it was defined to distinguish non-military engineering from military engineering. It is traditionally broken into several sub-disciplines including environmental, geotechnical engineering, geophysics, geodesy, control engineering, structural engineering, biomechanics, nanotechnology, transportation, earth science, atmospheric sciences, forensic engineering, municipal or urban engineering, water resources engineering, materials engineering, coastal engineering, surveying, and construction engineering.

Civil engineering takes place on all levels: in the public sector from municipal through to national governments, and in the private sector from individual homeowners through to international companies. Civil designer uses above concepts of fundamental physics for the construction of better or innovative civil work.[5]

2.6 Physics of Superconductors

A superconductor is an element, a metallic alloy, or a compound that will conduct electricity without resistance below a certain temperature. Electrical current once set in motion, will flow “forever” in a closed loop of superconducting material. This makes it the closest thing we know to a perpetual motion machine we have today.

Superconductivity was first observed in 1911 by a Dutch physicist named Heike Kammerling Ones. He used mercury and cooled it to the temperature of liquid helium, which is 4.15 degrees Kelvin. When the mercury reached this temperature, its resistance suddenly disappeared, meaning that electrical current flowed freely through it.

In 1933, Meissner and Ochsenfeld discovered effect of diamagnetism of superconductors, known as the “Meissner effect.” A magnet moving by a conductor induces electric current in the conductor. It is the basis for conventional generators. With a superconductor, however, the magnet is repulsed as the induced current exactly mirrors the field that would otherwise have penetrated the superconductor. This is known as diamagnetism and can cause a magnet to actually be levitated above superconductor material.

The concept of magnetic levitation (the Meissner Effect) was introduced earlier. It is one area where superconductors perform very well. Trains can be made to "float" on strong superconductor magnets, thus eliminating the friction between train and tracks. The worlds' first MAGLEV train was a shuttle in Birmingham, England. It shut down in 1997 after 11 years in operation. Other lines include on in Shanghai at Pudong International Airport, and one will begin in late 2004 at Old Dominion University in the US. However, widespread use to this point has been limited by political and environmental concerns. Strong magnetic fields can create a biohazard and the impact is under research.

Other potential uses for MAGLEV technology include building MAGLEV systems along the right-of-way of existing interstate highways to carry both passengers and freight more efficiently and cheaply without being as dependent on fossil fuels. Another, more or less futuristic idea is to use low pressure tunnels for the vehicles, thus cutting down air friction. The vehicles would theoretically travel at super speeds at up to 2000mph, again carrying freight and/or passengers. The technology has been extended to things like cheaply transporting water, carrying crushed rock in mining operations, and even in space flight. The idea here would be to move the rocket over a MAGLEV line in a low pressure tunnel until it reached a certain speed, then curve it upward for launch, at which time the conventional rockets would kick in. The amount of conventional rocket fuel would be considerably lessened, making it cheaper to launch a space vehicle.

Other applications now under research include using superconductors to increase the speed and processing power or computers, using the technology in superconducting X-Ray detectors, light detectors, digital routers, and electric storage capability and on and on. The US Navy is looking at using smaller motors based on superconductor technology. The uses of superconductor technology seems only limited by the inventiveness of the researchers looking at new applications. [4, 5]

III. CONCLUSION

Physics; when interlinked with technological disciplines; enhances the logical, analytical, inquisitive and application oriented thinking of techno-learner. This enables technocrats to offer services to the industries and society with more efficiency.

It is not in nature of any one person to make a sudden and violent discovery. The combined wisdom of thousands of persons, who are thinking the same problem, brings out solution of single scientific idea. Technologists try to put these ideas in development and automization of the system, so that human being will have to take less physical efforts on any particular task. Thus, according to Ernest Rutherford 'Science goes step by step and every man depends on the work of his predecessors'. In the era of technocracy the sustainable development will be achieved only when the technocrats and scientist will proceed with combined efforts.

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