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American Academy of Mechanics
Academia Americana de Mecánica

CONFERENCE ANNOUNCEMENT

VirginiaTech

Invent the Future

TWELFTH CONFERENCE
on
NONLINEAR VIBRATIONS, DYNAMICS, AND MULTIBODY SYSTEMS
June 1-5, 2008
The Inn at Virginia Tech and Skelton Conference Center
Virginia Polytechnic Institute and State University
Blacksburg, VA 24061

GENERAL INFORMATION:

The twelfth conference in this series will be held at The Inn at Virginia Tech and Skelton Conference Center on the Virginia Tech campus on June 1-5, 2008. The scope of the conference includes:

- Multibody dynamics: rigid and flexible multibody systems, impact and contact mechanics, solution of DAE, vehicle and tire modeling, railroad vehicle dynamics, biomechanics application, computer algorithms,
- MEMS,
- Dynamics of composite structures,
- Adaptive structures,
- Fluid/structure interactions,
- Nonsmooth dynamics,
- Multi-scale dynamics,
- Parametric vibrations: single- and multi-frequency excitations of single- and multi-degree-of-freedom systems,
- Computational techniques: efficient algorithms, use of symbolic manipulators, integration of symbolic manipulation and numerical methods, use of parallel processors,
- Experimental methods: benchmark experiments, measurements in hostile environments, instrumentation techniques,
- Influence of nonlinearities on control systems, and
- Identification of nonlinear systems.

Authors will have the option of submitting full-length papers to be considered for publication in NONLINEAR DYNAMICS or THE JOURNAL OF VIBRATION AND CONTROL. To accelerate the reviewing process, we will select referees from those who will attend the conference and mail the manuscripts to them before the meeting.

Steering Committee: Kurt Anderson, Bala Balachandran, Tom Burton, Ali Nayfeh, Friedrich Pfeiffer, Giuseppe Rega, Subhash Sinha, Fabrizio Vestroni, Hiroshi Yabuno

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DEADLINES:

The deadline for two-page abstracts is February 15, 2008.
The deadline for full-length papers (optional, see above) is April 15, 2008.
The deadline for early registration is April 30, 2008.
The deadline for conference registration is May 16, 2008.
The deadline for hotel reservations under the room block is April 30, 2008.
The deadline for cancellations is 5PM May 23, 2008. (see conf. reg. website below for cancellation/refund policy)

For updates and more information, please refer to our website at: http://www.esm.vt.edu/~anayfeh/

Conference registration https://www.cpe.vt.edu/nonlinvib/

A block of lodging rooms is being held at The Inn. The lodging rate for this conference is US$103 plus applicable taxes. Participants are responsible for making their own lodging arrangements. Lodging reservations should be made by April 30, 2008. Lodging: www.TheInnAtVirginiaTech.com

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VirginiaTech

Invent the Future

The Mechanics Conference
To Celebrate the 100th Anniversary of
The Department of Engineering Science and Mechanics
May 29 & 30, 2008
The Inn at Virginia Tech and Skelton Conference Center
Virginia Polytechnic Institute and State University, Blacksburg, VA 24061

GENERAL INFORMATION:

Virginia's senior land-grant university, today the Virginia Polytechnic Institute and State University, more commonly known as Virginia Tech, was founded in 1872, and just thirty-six years later in 1908, mechanics became an identifiable separate entity in the College of Engineering. During its one-hundred-year history the department housing mechanics, like the University itself, underwent several name changes, and today it is known as the Department of Engineering Science and Mechanics.

As part of the activities to celebrate its centennial, the Department is hosting a two-day mechanics conference on May 29 & 30 at The Inn at Virginia Tech and Skelton Conference Center. All interested mechanicians are invited to submit one-page abstracts related to any aspect of fluid mechanics, solid mechanics, materials, dynamics and control, and biomechanics, as well as emerging areas in mechanics.

In addition to the parallel sessions of the conference, there will be a banquet in the evening of the 29th. The University's golf course adjoins the grounds of the conference center.

DEADLINES:

The deadline for one-page abstracts is February 15, 2008.
The deadline for conference registration is May 16, 2008.
The deadline for cancellations is May 1, 2008 at 5PM. (see conf. reg. website below for cancellation/refund policy)

For updates and more information, please refer to our website at: http://www.esm.vt.edu/

Conference registration http://www.cpe.vt.edu/mcesm/ - this website will be up and running soon

A block of lodging rooms is being held at The Inn. The lodging rate for this conference is US$103 plus applicable taxes. Participants are responsible for making their own lodging arrangements. Lodging reservations should be made by May 1, 2008. Lodging: www.TheInnAtVirginiaTech.com

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POSITIONS AVAILABLE

COLLEGE OF ENGINEERING
ALFAISAL UNIVERSITY
Riyadh, Saudi Arabia

Alfaisal University is a private, not-for-profit, research university, comprised of the Colleges of Engineering, Science and General Studies, Medicine, and Business, and will commence its programs in Fall 2008. The language of instruction is English and modern learning outcomes, paradigms and technologies are used. The university was founded by King Faisal Foundation along with organizations such as Boeing, British Aerospace, Thales, and King Faisal Specialist Hospital & Research Center, which serve on its Board of Trustees.

The College of Engineering will offer undergraduate and graduate programs in the following disciplines and areas: **ELECTRICAL** (power, communications, signal processing, electronics, photonics, remote sensing and geodata analysis), **COMPUTER** (intelligent systems, language and speech, computer systems, computation), **MECHANICAL** (applied mechanics, thermo/fluid engineering, product creation), **AEROSPACE** (propulsion, aerospace systems, transportation, system dynamics and control), **MATERIALS** (materials processing, materials properties and performance, polymers, nanoscience and technology), **CHEMICAL** (catalysis, reactor design, separations, design-systems). All programs have been developed by renowned scholars from leading universities in the US and the UK, and are designed to be qualified for accreditation according to US and UK standards and requirements.

Alfaisal Engineering seeks candidates for the following positions, commencing in August 2008: **FOUNDING SENIOR FACULTY** (with research, instructional, and administrative responsibilities), **RESEARCH SCIENTISTS** (academics with research focus), **LECTURERS** (academics with instructional focus), **POST-DOCS** (Doctoral degree holders with research focus), **INSTRUCTORS** (Master's degree holders with instructional focus), and **ENGINEERS** (Bachelor's degree holders). Attractive salary and start-up support is provided. Queries and applications should be sent to engnr_recruiting@alfaisal.edu. The subject line should specify the discipline, area, position, and the announcement reference. The deadline for applications is 31 December 2007. Interviews for leading positions will be conducted in January and February 2008 in Cambridge, MA, USA, and Cambridge, England, UK.

The Institute for Shock Physics at Washington State University has openings for junior and senior research positions in computational mechanics.

Research Scientist – Computational Mechanics
Applied Sciences Laboratory (ASL), Spokane, Washington

Researchers in ASL undertake applied research in the physical sciences and engineering for the Institute for Shock Physics. We are seeking a Research Scientist to undertake and lead computational modeling and simulation activities related to the mechanical response of materials. We are looking for a creative, self-motivated, entrepreneurial individual who has the ability and interest to address challenging, interdisciplinary problems in a fast paced applied research environment. Preference will be given to individuals who can strengthen and enhance ongoing computational research activities related to mesoscale modeling. View the complete notice of vacancy at http://www.asl.wsu.edu/site/careers.html.

Postdoctoral Research Associate – Computational Mechanics
Pullman, Washington

We have an immediate opening for a postdoctoral research associate to undertake modeling and simulation activities related to the dynamic response of materials.
We are looking for creative, self-motivated individuals who have the ability and interest to pursue challenging, interdisciplinary problems in a fast paced research environment. Applicants may view the complete notice of vacancy at http://www.shock.wsu.edu/opportunities.html .

CONTRIBUTED ARTICLE

HOW TO COPE WITH CHANGE

Senol Utku, Sc.D.[1]

ABSTRACT

The universe is in perpetual change. Yet, in all cultures, persons, organizations, and institutions (shortly, we) complete our life-cycles within some fixed norms that may or may not be compatible with the changing universe around us. We may fight to keep our norms or we adapt them to the changing environment, whichever best ensures our survival. The work discusses this issue for education, specifically engineering education, where the problem appears more acute. The acuteness stems mostly from the high rate of human-made changes (as opposed to natural changes) that results from our eagerness to reach where we want to go as quickly as possible without sufficiently studying our goal for: 1) global benefits and harms that may emanate from it, 2) tools and methods for reaching it, and 3) long-term consequences of reaching it alone. This eagerness originates mainly from the worldly benefits that individuals and groups of individuals are rewarded by their achievements regardless 1), 2), and 3). As soon as they are positively identified the natural changes are dealt with, by using the well-established and continuously updated engineering tools and methods, whereas the human-made changes must be carefully scrutinized first. The trends in engineering education, specifically those in civil engineering, in meeting the natural and the human-made changes are discussed.

1. INTRODUCTION

Current consensus among world's physicists is that we may have an ever-expanding universe[1]. It was a pulsating universe when the author started his doctoral studies in 1957. In either case, the universe, hence everything in it, is in perpetual re-adjustment. Yet in all cultures, persons, organizations, and institutions, as well as all life forms, and physical systems (shortly, systems to include both natural and human-made) try to complete their life-cycles within some fixed norms that may or may not be compatible with the changing universe around them. Most of the successful systems are initially designed to

- resist the small changes by *over-design*, and
- allow *adaptability*[2] for self-modification without endangering structural integrity when the change is large but gradual and is not too excessive.

Many systems are not initially well-designed, hence lack built-in strength or planned adaptivity, in order to meet changes that are too strong or too fast relative to their design-life. These are the unsuccessful systems that fail under large pressures due to environmental changes and become extinct.

The question is how homo sapiens and their creations stand up with respect to this assessment? *Confining to the physical world only*, this will be examined in the following sections. We will discuss how to sense and measure changes affecting humans and their creations in section 2, and how to cope with them in section 3. Their affect on engineering education is discussed in section 4. The conclusions that may be derived from these discussions are summarized in section 5.

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2. SENSING AND MEASURING THE CHANGE

If one wants to cope with changes in one's environment, one must first sense, and then measure them. The sensing and measuring will help one to decide if the change is good or bad, and if it is bad how to cope with it. Our sensing organs enable us to do the first level of sensing. But they are very crude tools, considering the wide range of possible changes that we must be aware of for our survival, such as, poisonous gases in our atmosphere, chemicals in our water and food, viruses, bacteria, and other obnoxious particles with which we are in contact, electro-magnetic-radiations, x-ray emissions, and many others that are beyond our sensing organs. Moreover changes that are within the range of our sensing organs may not be received by our consciousness due to our attention deficiencies, personal biases, ethical weaknesses, and agitated psychological states.

Human ingenuity and accumulated knowledge enabled us to create sensing devices for sensing and recording continuously the changes that are taking place around and within us, in distances from nanometers to zillions of astronomical units. These devices not only sense the changes but also measure them in units that are globally understood.

For example, consider the lab reports on blood samples. They contain not only the sensed measurements, but also their upper and lower bounds for healthy individuals. In recent lab reports, the measured quantity comes in boldface characters when it is outside the range for healthy individuals.

This example tells us that sensing and measuring alone usually do not tell us if we should be alarmed with the measurement. Knowledge must be generated on the levels beyond which the system may be in danger. This knowledge is essential for the start of any coping process.

As an example, consider the case of coping with the start of fires due to electrical shorts that may result after earthquakes. The easiest thing is to cut off the power in the power network when the earthquake starts. A seismograph may be useful to sense, measure, and record the earthquake accelerations, continuously. Since the earth is in perpetual vibration, at which level of the on-going accelerations, a cut off power signal is to be issued, is important, considering that a too early or too late issuance of the signal may induce unwarranted costs.

Since the mid-Twentieth Century notable advances have been taking place in the sensing and measuring technologies. Using the products of these technologies, the advances in the sciences and engineering increased to unprecedented levels, and as a result, our understanding of the physical universe, our galaxy, our solar system, our planet, the life in the planet, and the human body underwent remarkable developments. By these products we can see better, hear better, feel better, and hence decide better.

Modern technology provides us with the means of reading the telltales of past changes as they developed on Earth's surface, in the sedimentation layers at ocean bottoms, in the accumulated ice at polar regions and high elevations, and deep in the Earth's crust. We know with an ever increasing chronological accuracy, what has happened to our habitat since its creation. We also know that the nominal values of many life-related attributes of Earth have changed continuously during the billions of years before the time when Lucy[3] and her family walked in the steps of Africa some three million years ago.

Through the advances in communication technologies we can communicate faster and among extremely large number of terminal points, and through the computer technologies we can handle unbelievably large amounts of data every second and thus can reason much faster and more intelligently.

However, in teaching all these facts and facilities to the present and coming generations, we are failing terribly. As a consequence, we have created and continue to create haves and have-nots in all domains including, knowledge, wealth, health, happiness, and power, to count a few. The rate of change has been too much and it has occurred too fast, relative to average human life and learning ability, that our efforts for teaching these changes and their consequences have been too little and too inefficient.

3. HOW TO COPE WITH CHANGES IN PHYSICAL WORLD

Changes in physical world may be due to nature or due to human-made causes. If the changes are due to nature, one may call them natural changes. If they are caused by people and/or their doings, they may be called human-made changes. We will first discuss the natural changes and the way to cope with them, and then do the same for the human-made changes.

Natural Changes

As discussed previously, we need to observe continuously the attributes of the environment that may affect human life and human creations, with the objective of sensing, measuring, recording, and assessing their possible adverse affects on us. Modern technology provides tools for this. The networks of meteorological and seismological stations, the air pollution control stations, the observational satellites, ground based observatories, the Hubble telescope and the likes are some of our institutionalized public centers that continuously sense, measure, record, and assess the changes in many attributes of our environment. As a result of continuous sensing, measuring, and recording, we are provided with the statistical measures (such as mean, median, standard deviation, etc.) of the measurements that enable a professional or an *advanced artificial intelligence software* about the attribute's nominal value and upper/lower bounds of nominal deviations beyond which we should start thinking about the ways of alleviating possible dangers that may be associated with that attribute.

As a result of such sensing, measuring, recording, and analysis, we now know that the global warming and the related anomalies need be considered seriously for coping. In general coping with natural changes, one should try first to identify if the changes are due to natural causes or due to human-made ones. This is important since if it is due to human-made causes, we may try to remove the human-made factors with the expectation that the undesired changes will also stop. However, if the change is not human-made or it cannot be stopped by removing the human-made factors, then we may try to determine if it is a short- or long-duration one, since the coping method may be different for transient and non-transient changes. For example, for a long-duration global warming, we may have to learn to live with it by changing substantially our life-styles. For a short-term global warming we may use transient measures that may be determined by the experts.

Human-Made Changes

Most of our difficulties and also the conveniences in modern times are caused by human-made changes. Humans are creative animals, they create in order to meet their needs, and usually they become more creative under the increasing pressures of the need that originates from individual or social sources. Because of some need, if a human-made entity is created by some people at some locality, it starts spreading from the point of origin to its neighbors, and neighbors of the neighbors, and so on, until it encounters a physical barrier or a competing comparable construct of some other kind. As humans learned with increasing efficiency how to benefit from

- their minds,
- dexterity of their hands, and the
- accumulated knowledge in their societies,

their initial hunter-gatherer societies transformed gradually into agricultural societies and then into industrial societies, during the last ten thousand years since the creations in Catalhoyuk[4] and Sanliurfa .

In a dynamic world, changes propagate. So do the human-made changes among people. The propagation rates increase with the accumulation of advancements in technological fields. In an arbitrary categorization and order, some areas of human-made changes may be given as:

- Languages (natural, symbolic, mathematical, etc.),
- Tools (hunting, agricultural, fighting, hand-driven, power, automatic,etc.)
- Belief systems (astrological, shamanist, polytheist, monotheist, atheist, agnostical, etc.),
- Inscriptions (pictures, symbols, letters, etc.),
- Commerce (bartering, coins, banking, automatic teller machines, smart cards, etc.),
- Health care (witch-craft, nutritional, observational, acupunctural, medical, etc.)
- Travel, with help of:
    - animals,
    - man-driven mechanical devices that can go over land, water, and air
    - energy driven mechanical devices that use energy of:
        - other humans,
        - animals,
        - wind,
        - steam (e.g., locomotives, ships, railroads, etc.),
        - internal combustion (e.g., automobiles, airplanes, highways, etc.),

        - external combustion (e.g., jets, rockets)
        - electricity,
    - electrons (e.g., ion engines), photons (e.g., helio-gyros),
- Energy extraction (e.g., waterfalls, wind, solar, bio-fuels, coal, oil, fission, fusion, etc.)
- Documentation
    - clay tablets, stones,
    - papyrus leaves,
    - animal skins, paper,
    - phonograph records,
    - magnetic tapes,
    - core-memories,
    - printed circuitry memories,
    - magnetic read/write disks/drums,
    - laser read/write disks/drums,
- Biochemical developments (e.g., genome project, DNA splicing, root cells, etc.)
- Medical diagnostics (e.g., visual, auditory, surgical, magnetic resonance, ultrasound, etc.)
- Medical treatment (e.g., drugs, non-evasive techniques, evasive techniques, etc.)
- Pharmaceuticals (e.g., drugs, food-supplements, etc.),
- Send/receive devices for communication, using
    - direct current,
    - electro-magnetic waves with ever-increasing frequencies, and
    - photons,
- Data processing using micro chips that can repeat *retrieve-process-store* cycle using
    - electrons,
    - photons
- Automatic control systems that can repeat *sense-process-actuate* cycle to keep systems on desired trajectories using
    - analogue data or
    - digital data.

The human-made changes in all these and other areas, have propagated with ever-increasing rates. Borrowing terms from the theory of partial differential equations, the familiar *non-elliptic* world is quickly becoming an *elliptic*[5,6] world where changes propagate with infinite velocity; hence there is no boundary (i.e., *characteristic line or characteristic surface*) between the people with the knowledge of a particular human-made creation and the people without that knowledge. For example, in the medieval ages there was a boundary between the people with the knowledge of a magnetic compass and the people without that knowledge. Hence, with respect to compass, in medieval ages, the world was definitely non-elliptic. In modern times, in many issues, the world is elliptic, and in many other issues, it is non-elliptic but with rapidly vanishing boundaries. For example, presently, as far as cell-phones are concerned the world is practically elliptic, but as far as accessing-to-medicine is concerned it is definitely not.

The abundance of these human-made changes and their positive contributions to human life, may have caused the rapid increase of human population in the world. When the author started his elementary school education in 1938 at the Sultanahmet district of Istanbul, the city's population was around 650,000, now it is over 15 million. Although Lucy[2] and her family were very lonely in the steps of Africa three million years ago, we are crowded now with over 6 billion people on Earth. Considering finiteness of Earth's resources, it is scary to imagine the end of this trend. Population increase is definitely a human-made change that needs be seriously considered.

The creation of any physical entity, in addition to many other things, requires material(s) and energy, but also produces many undesirable by-products. The use of the physical entity produces not only convenience and benefit, but also waste and pollution. There are examples of products that started as great help to human welfare but ended up as a great danger to humanity as a result of misuse. A couple of them are mentioned below:

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[2] *Op. cit.*

Model T of Henry Ford was a great travel device that Ford himself said he would make every individual to own one in his life time. His enthusiasm was shared by many. It is still being shared by millions of us all over the world. **As a result, most of the carbon, captured by the plants and buried in Earth's crust during the past billion years, we transported into the atmosphere in about a century.** Now we may be suffering worldwide its consequence as global warming, in addition to the highway deaths, which is about 50,000 per year in the United States alone.

Many other things happened on the way of transporting carbon into the atmosphere using the internal combustion engines. For example, a Thomas Midgley, Junior, a chemical engineer, discovered that tetraethyl lead added to gasoline stopped the engine knocking, thus he created leaded gasoline[7]. General Motors, Du Pont and Standard Oil of New Jersey, under Midgley's entrepreneurship, created in 1923 the Ethyl Gasoline Corporation. It was a very profitable business until it was sold in 1968. Since the lead in air is extremely detrimental to human health, leaded petrol was outlawed from sales in the United States in 1986, after lots of damage to lots of people.

One may extend the list of human-made entities, subjected to **misuse** or **incompetence** or **human greed** in their use, by many others: such as nitro-glycerin, chlorofluorocarbons, x-rays, nuclear fission, automobiles, languages, politics, religions, administrative systems, businesses, and internet, etc. Clearly the negative effects of human-made changes are increasing rapidly with their world-wide spread and ubiquitous usage, to levels that endanger our species in particular, and life in the planet in general. This is because Earth's life giving resources are finite, and Earth is the only habitat of life, as we currently know.

We can survive only on Earth which is a tiny planet of an insignificant star in an ordinary galaxy of a universe that is crowded with zillions of such galaxies. The negative effects of human-made changes must be coped with seriously and without delay.

Coping with Human-made Changes

Before a human-made change is deployed or used commercially or allowed for spread, the following should be done: The goal must be carefully studied for the

- global benefits and harms that may emanate from it,
- tools and methods for reaching it, and
- long-term consequences of reaching it alone

by agencies, such as United Nations, or Sierra Club, or other similar watch-dog organizations that are authorized to make such studies. If the human-made change is already propagated and found that its unwanted affects will be more than its benefits or conveniences, its further spread may be stopped by

- assessing large punitive means to those who push for its continuance,
- modifying it so that the modified entity has no unwanted attribute,
- confronting it by a competitive entity without the bad attribute.

For survival, we must raise the future generations by teaching that our habitat is small and with finite resources, and our creations must be towards preserving it, not towards destroying it.

4. HOW TO COPE WITH THE CHANGES IN ENGINEERING EDUCATION

Engineering is a field to create new technological products and production methods to enhance the sensing, moving, thinking, and imagining capabilities of humans for perpetuating their species and their habitat without any harm. **Supported by the basic sciences and human creativity, the engineering field is flourishing with the technological breakthroughs in all its sub-fields.**

Like everything else the state of engineering is changing. Rather than *change*, it may be more insightful to talk about the *incremental change* from a reference state of an earlier time. The end of the Second World War marks the beginning of nuclear age, electronics age, digital processing and control age, space age, high speed communications age, the age of new materials, age of the extremely large, age of the extremely small, and many others. Since very little or none of these existed before, presently, the incremental state is also the actual state for these fields.

How does the engineering education in universities cope with these changes? I believe successfully by enlarging the scope of existing departments, adding new departments, creating new institutes and laboratories, and reflecting them into the undergraduate and graduate education by creating new courses of study, making

changes in the existing ones, and modifying the requirements of degree programs, and so on. The prime responsibility of any university is to

- teach the knowledge the humanity already has, to the incoming generations,
- enlarge the knowledge whenever possible, and
- cast knowledge into forms that are easily accessible, teachable, and referable.

Using the recent scientific and technological advancements, they can fulfill these functions better. Since the universities are the backbone of human progress, they must be supported by all, especially by those who has the necessary resources.

Coping with the social changes is a much harder issue in engineering education in universities, especially when the social inspirations run against its functions. Since engineering and engineering education are vital for the survival of any society, it cannot afford to be influenced by the negative trends. Until less-developed societies are brought to the contemporary levels of science and technology, perhaps its less complex earlier states may be used until all segments of the society catch up.

Scientific and technological activities are based on rational methods and sound principles, hence they are additive, and their state trajectory in the (state, time) space is never with a negative slope. However there are other difficulties need to be seriously considered, in the categories of

- wider-use of older technologies,
- too-early use of yet-to-be perfected technologies, and
- too-late use of existing technologies.

The use of an inappropriate technology or a proper technology that is used improperly can cause difficulties. In the past, some of these have caused unwanted changes in *human population in size or demography or both*, and some others have started *hurting human habitats*, and still others *humans themselves*.

Examples of the difficulties in the **category of wider-use** include the cases of

- internal combustion engines,
- leaded gasoline, and
- highway deaths

that were mentioned earlier, in the previous section.

Examples of the **category of too-early use of new but yet-to-be perfected technologies** include many.

One that the author still remembers is the *thalidomide incident* of late Fifties and early Sixties when lots of babies were born with birth defects in Europe and elsewhere because of the release of the *medicine thalidomide*[8] without sufficient testing. The damage would be much larger if it were not for the rules of Food and Drug Administration of the United States that prevented its use in the States.

The Chernobyl and the Three Miles Island accidents of nuclear power industry are also examples of the too-early use of yet-to-be perfected technologies. For this industry there are also many other issues related to the international law, such as

- What do you do with the nuclear waste (spent-fuel)?
- Who pays for the nuclear accident caused damage-to-other-countries?
- Who decides the location of a nuclear power plant, if one wants to minimize the global damage from a possible melt-down?

yet to be seriously considered.

Examples of the **category of too-late use of existing technologies** include the destruction of the city of New Orleans, the home of Superdome and the jazz capital of the world, by Hurricane Katrina[9] in 2005. As part of his doctoral program that started at MIT in 1957, the author had to take a graduate course on *Soil Mechanics* where he was taught that the city of New Orleans, like Boston and Mexico City, was built over highly compressible clay layers, and also a graduate course on *Hydrology* where he was taught about the hurricanes that are still devastating the Gulf of Mexico area of the United States. Perhaps the city fathers responsible for the physical well-being of New Orleans were aware of the underlying clay layers and were warned that the clay underneath should not be confronted with additional loads of the rapidly developing city. The Corps of Engineers of the United States Army, the federal agency responsible for the public works in domains not covered by the commercial enterprises, proposed for years to upgrade the levees around the sinking city. However, for decades the politicians ignored the danger until Hurricane Katrina hit the levees and created lots of death and damage. The list of examples of this category also include the space shuttle Challenger Accident[10]

that killed six astronauts and my teacher-colleague Christa McAuliffe, and stopped NASA's shuttle program for years.

To cope with the occurrence of such events one must include in the decision making process, the opinions of those who created the technology and also those who may suffer the side effects, together with a wide public discussion of feasibility reports. Perhaps, as my instructor in the *Elements of Construction* course that I took in 1950 during my sophomore year at Istanbul Technical University, Professor Ali Fuat Berkman, used to say "either the administrators should be engineers or the engineers should be administrators", in this age of science and technology.

5. CONCLUSIONS

From the discussions of this paper the following conclusions may be reached:

- Since the universe is changing, everything in it, including the state of engineering and engineering education are also changing.
- Changes must be sensed and measured before coping.
- Human-made changes are distinct from natural changes.
- A system may be kept on a desired trajectory either by over-design or by adaptation.
- Engineering / engineering-education, uses its own rational methodologies and sound principles to enlarge its own domain to handle the changes.
- Imperfect, defective or obsolete technologies are bad for humanity and its habitat. New technologies may be created to prevent their further use.

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