

February 28, 2011

TO: Dr. Raymond W. Alden III, Executive Vice President and Provost, NIU
Dr. Promod Vohra, Dean, College of Engineering and Engineering Technology, NIU
Dr. Simon Song, Chair, Department of Mechanical Engineering, NIU

From: Milivoje Kostic, Professor of Mechanical Engineering, NIU



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RE: Sabbatical Activities Report

For Fall 2010 Semester (August 16, 2010 to December 31, 2010)

I. Summary of Sabbatical Activities

The purpose has been to initiate and develop new critical and practical activities at NIU as related to national and global “*Energy and Ecology Challenges*.” In addition, the goal has been to develop activities and proposals for funding of a model *Energy Efficient (Green) Building* on NIU Campus, an energy landmark to house interdisciplinary energy & environmental programs to be developed.

During my sabbatical semester many critical activities has been conducted and background research with specific outcomes completed. However, due to “ambitious” nature of the proposed objectives and temporary “recession” of suitable funding sources, an aggressive institutional collaboration and support are necessary for development of future funding. More specifically, originally available, “*The American Recovery and Reinvestment Act (2009 ARRA)*” funding for proposed building renovation has been expired, as well as usual funding for landmark “*Green Energy Buildings*.” The challenges for undertaking proposed activities in a semester time have been bigger than expected, but so are the potentials and opportunities for NIU. The activities and collaborations are commenced and continuing and if given due institutional priority and support, multiple future proposals are expected.

After the sabbatical research and consultation with external experts it has been concluded that development of a *Northern Illinois Regional Energy Center* with focus on *energy education and energy conservation, efficiency and sustainability*, by integration of all available and new to be developed energy conservation practices and efficient technologies including energy renewable and sustainable resources, is much more suitable for funding than originally proposed landmark “*Green Energy Building*.” A background research is completed for development of unique, interdisciplinary *Master of Energy Science and Technology (MEST)* program. The proposed interdisciplinary energy activities are more suited for NIU profile and the NI Region than any specific cutting-edge research proposal and, therefore, should be given due consideration and priority. There will be more need for quality energy education and energy-related jobs at all levels along with innovative and efficient energy technology development and applications, and NIU should be proactive and more aggressive participant and contributor to the regional, national and global needs.

II. Description of Sabbatical Activities and Specific Proposals

I have proposed ambitious institutional objectives, took a risk, and the results of my sabbatical activities are described next. This time, I have conducted my sabbatical activities “in-house” at NIU. In addition, I have been fully involved in conducting regular, on-going funding research project with Argonne and advising several graduate students working in CFD and nanofluid research areas. However, my priority has been the work on energy initiatives as proposed in my sabbatical application. Actually, my primary, previous and current research interests and activities have been in the energy fundamentals and applications, with emphasis on energy conservation and improvement of energy efficiency in energy conversion and utilization processes, including recent initiatives and related *Building Energy Efficiency* activities.

I have been trying for a number of years now to get due attention of NIU administrators about need, importance and benefits for NIU energy initiatives, but has not been successful to earn funding within NIU strategic initiatives. However, I have been approved this sabbatical leave to work on these energy initiatives and hope they will be now accepted, promoted and supported as a critical NIU future priority. The proposed sabbatical activities and objectives have been ambitious and unique, since they relate to the university-wide and region-wide collaborative activities and funding, as opposed to a customary, focused and narrow research activity of an individual faculty. At the time of the sabbatical application, I have been collaborating with a local company, a producer of an innovative energy-efficient wall and roof panels, to promote building energy efficient products and practices for public benefits, see my Web postings and other references. With support of ex-Congressman Foster and CEET, I have been developing collaborative activities, and initiating a work on an important NIU proposal development to obtain stimulus funding for retrofitting NIU existing buildings (see elsewhere). However, regrettably “*The American Recovery and Reinvestment Act (2009 ARRA)*” stimulus funding for proposed building renovation has expired in meantime, as well as usual funding for landmark “*Green Energy Buildings*.” I realized that developing suitable funding for proposed activities will require institutional support, since the proposals are not specific research topics, but rather multidisciplinary and collaborative institutional initiatives requiring substantial funding. My sabbatical activities have been focused in three different areas:

- (1) Searching for suitable funding sources for proposed objectives to *renovate NIU buildings* and built *Energy Efficient (Green) Building(s)* at NIU.
- (2) Developing proposal for whole specter of *Energy-Environmental Educational Programs*, including a professional multidisciplinary *Master of Energy Science and Technology (MEST)* graduate program.
- (3) Developing proposal for alternative option to the *Energy Efficient (Green) Building* at NIU: Establishing *Northern Illinois Regional Energy Center*.

(1) Searching for suitable funding sources for proposed objectives:

Since the originally available stimulus funding (“*The American Recovery and Reinvestment Act - 2009 ARRA*”) to renovate NIU buildings and to built a landmark *Energy Efficient (Green) Building* at NIU has expired in the meantime, I have contacted Chair Song, Dean Vohra, and Dave Stone of NIU Pponsored projects in Spring/Summer and early Fall 2010 semester, to help research and possibly develop suitable funding for the proposed campus-wide activities (see attached). Since the suitable funding could not be found at the time, I have discussed (in early November) diverse possibilities to collaborate on joint proposals with UIC’s *Energy Resources Center* (John J. Cuttica, Director and Henry C. Kurth, Assoc. Director) since they have a long tradition of working on diverse energy projects funded by regional, state and federal governments. They have stated that they are interested in collaboration but it will take time to involve their relevant academic departments. They also stated that it will be a challenge now to obtain funding for a landmark “*Green Building at NIU*” due to the current deficit of government funding for such purposes, but they suggested that developing a *Regional Energy Center* with emphasis on education and energy conservation would be more appealing. More lately I have been talking with Dean Vohra and Associate Dean Tahernezehadi, as well as Dave Stone and Lori Clark, to collaboratively work on developing funding sources.

The followings are two specific proposals:

(2) Proposal for whole specter of “Energy-Environmental Activities and Educational Programs,” including a professional multidisciplinary “Master of Energy Science and Technology (MEST)” graduate program.

Many educational and other institutions and industry have been positioning their strategic and development activities in energy related area, including campus-wide ‘green & sustainable’ initiatives, energy-related educational programs at all levels, and energy-related research, development and application. *NIU is not YET in the forefront!* There is deficit of synergistic and comprehensive campus-wide quality activities – pragmatic activities not integrated and without due vision, enthusiasm and rigor. Up to date, the CEET’s energy activities have been pragmatic and without due integration and focus on long-term, “profitable” and thus sustainable future programs.

There will be more and more needs for *quality energy education* at all levels along with efficient energy technology development and applications, and NIU should participate and be proactive contributor to the regional and global needs. We should start now “*leading by example and expertise*” from within our campus and then promote and expend to the region and globally. Activities could be initiated within our existing programs including enthusiasts, activists and interest groups, to develop related proposals and funding for future sustainable activities, to develop new skilled labor force for new businesses, to engage to the most challenging and thus most profitable energy issues.

I propose that NIU initiate a vital campus-and-region-wide environmental sustainability activities with objective to reduce cost while developing, promoting and implementing energy efficiency and conservation, and measures of resource conservation and sustainability. Leading by example and expertise, those activities, if promoted and given due priority, should result in important savings, educational and job market growth, and external projects beneficial to all in Northern Illinois region.

The right timing is now, due to need for savings and availability of new economical technology and expertise. We should establish a campus-wide *Sustainability Task Force* or similar entity, including staff, professors and students, as well as local business and government enthusiasts and environmentalists, in order to initiate, promote, develop and implement conservation, efficiency and sustainability measures. The proposed sustainability activities should be “*talk and action of the whole campus and wider community,*” including academic and student affairs’ divisions, in addition to administrative affairs’ physical plant regular business.

We should encourage all students, faculty and community members to participate in the conservation, efficiency and sustainability activities at NIU. We could do some exemplary projects - a critical conservation efforts that not only conserve energy and resources, but more importantly, save money and promote our institution image and opportunities towards the future educational programs, economy and job market growth.

A new campus-wide assessment related to building energy and water conservation, waste management and recycling, transportation, purchasing, research and curriculum and other related activities should be initiated and developed. Even simple energy-saving techniques, like implementing energy-efficient lighting, enhancing insulation and reducing ventilation losses, low-flow faucets and shower heads, if not already fully implemented, will be easy and exemplary projects, not to mention more advanced optimization management and control of energy and other resource processes using “smart” sensors with microprocessor control, all integrated into advanced computerized management systems. Now, and even more so in the future, new technologies prompted with continuous development of computerization, information and micro-nano-technology are becoming more reliable and economical. Who could dare in the past to predict current development of new and information technology, or that today’s hybrid \$20K cars could make close to 100 mile-per-gallon efficiency. Possibilities and opportunities are often beyond our beliefs.

I propose to develop a specter of well-intergraded and multidisciplinary *energy-related educational programs* for undergraduate degree, professional development (outreach), including a *Master of Energy Science and Technology (MEST)* graduate level degree. New *Master of Energy Engineering* programs have been developed at many institutions, like UIC (www.mie.uic.edu/programs/mee.htm) and Swiss Federal Institute of Technology's ETH-Energy Science Center (www.esc.ethz.ch; www.master-energy.ethz.ch), which I was invited to visit in summer 2009 and have access to some of their resources. Google search for “Master of Energy” returns several million hits. As part of my (pre)sabbatical activity I have developed a proposal for a new course, MEE 455 - *Energy Conservation and Environmental Sustainability*, as part of expanding our ME Department curriculum with “*energy emphasis,*” for example. Work on a manuscript “*Energy conservation, efficiency*

improvements, and use of renewable energy sources for economical and environmental sustainability,” is in advanced stage for future publication.

**(3) Proposal for alternative option to the Energy Efficient (Green) Building at NIU:
Establishing Northern Illinois Regional Energy Center.**

Any ambitious new activities and programs require appropriate “*intellectual-estate*” and “*real-estate*,” i.e., a commensurate investment of resources and time. It is concluded during this sabbatical research that in these competitive times it has been difficult to develop funding for a demonstration-like, a landmark NIU *Energy Efficient (Green) Building*, but instead, it is more realistic to develop institutional funding and external support for a *regional energy center* which will prepare energy-related skilled labor force and innovative efficient technologies and resources.

Therefore, it is proposed here to establish a *Northern Illinois Regional Energy Center* and develop critical multidisciplinary programs and funding resources. Furthermore, it is proposed to integrate the existing regional *Freedom (Renewable Energy) Field* in Rockford, with already multi-million dollar federal investment, and substantially enhance it with existing and new to-be-developed efficiency-and-conservation technologies.

The *Freedom Field* initiative and activities up to now are invaluable and should be commended. However, since the reality of global *energy landscape* has changed and is always changing (from hydrogen to alternative and renewable energy sources, and more and more to energy efficiency and conservation), NIU now could help in further strategic planning and development of major funding for continuation and expansion of this unprecedented initiative, into a comprehensive *Northern Illinois Regional Energy Center*. In addition to technological experts involved, there is a need for renewed vision to assist in critical decision making and energy development of our region (and YES, *Thermodynamics, a science of energy, and the Mother of All Sciences will provide needed vision!* – see www.kostic.niu.edu/energy). We have a unique opportunity to rejuvenate the “ailing” *Freedom Field* energy project – it is a unique initiative and could be much more important than what it appears to be – as one-of-a-kind energy landmark of our region and our state, it may have enormous potential for economic growth and new jobs in our region and nation.

I envision the proposed *NI Energy Center* as a very important energy landmark (of regional importance, far beyond the Freedom Field’s “*renewable energy technology demonstration*”), with a mission of developing an energy vision, renewable and alternative energy resources, and energy efficiency and conservation technologies, similar, but scaled-down and uniquely adapted, to the *National Renewable Energy Laboratory's* (NREL's). The project should be both, educational (to provide public interest and support) and show-case of diverse, existing and future energy technologies (to stimulate existing and new businesses). It should be a unique, contemporary energy theme-park with up-to-date resources for growth of energy-environmental related businesses. I strongly recommend development and implementation of fundamental and comprehensive energy efficiency and conservation (now marginalized in the project) and other renewable and alternative energy resources, where new jobs and consumer market is and will be. An excellent example: the fast expanding hybrid cars ([Prius phenomenon!](#)) which “ingeniously” adapt, enhance and optimize the existing technology to substantially improve energy conservation and efficiency. The *NI Energy Center* should emphasize importance of energy management-and-conservation (improving efficiency) and diversity of energy resources (particularly alternative and renewable energy resources), as well as environmental pollution and safety.

The strategic/resourceful/educational *NI Energy Center* (with Energy Freedom Field) major themes should be developed to provide vision and guidance for future activities, fund-raising and economic development. We could discuss scope and priorities of eight (8) major energy activities as given in my recent [Encyclopedia of Energy Engineering and Technology](#) article [Energy: Global and Historical Background](#), and after thorough discussion and modification, decide on our future vision and main objectives and actions.

A probable scenario ... in the wake of a short history of fossil fuels’ abundance and use (a blip on a human history radar screen), the following energy future activities, in order of practical urgency but all (diversity) are critically important:

1. Creative adaptation and innovations, with change of societal and human habits and expectations (life could be happier after fossil fuels’ era).
2. Intelligent hi-tech, local and global energy management in wide sense (to reduce waste, improve efficiency and quality of environment and life).

3. Energy conservation and regeneration have unforeseen (higher order of magnitude) and large potentials, in industry, transportation, commercial and residential sectors.
4. Nuclear energy and re-electrification for most of stationary energy needs.
5. Cogeneration and integration of power generation and new industry on global scale (to close the cycles at sources thus protecting environment and increasing efficiency).
6. Renewable biomass and synthetic hydro-carbons for fossil fuel replacement (mobile energy, transportation, and chemicals).
7. Advanced energy storage (synthetic fuels, advanced batteries, hydrogen...).
8. Redistributed solar-related and other renewable energies (to fill in the gap...).

Perhaps our greatest challenges, and thus opportunities, are in promoting and developing a sustainable future related to energy production and consumption. Energy is ultimately the basis for a large part of the global competitiveness, and more of it will be required to raise living standards in the developing world. Because of the fossil fuels' issues (nonrenewable limited supply, cause of pollution and possible climate change), finding sustainable and economical, renewable alternatives is becoming increasingly urgent. Most probably new ideas and investment in related areas will be the most needed and profitable.

The two things are certain in not distant future: (1) the world population and their living-standard expectations will substantially increase, and (2) the fossil fuels' economical reserves, particularly oil and natural gas, will substantially decrease. The difficulties that will face every nation and the world in meeting energy needs over the next several decades will be more challenging than what we anticipate now. The traditional solutions and approaches will not solve the global energy problem. New knowledge, new technology, and new living habits and expectations must be developed to address both, the quantity of energy needed to increase the standard of living world-wide and to preserve and enhance the quality of our environment.

However, regardless of imminent shortages of fossil fuels, the outlook for future energy needs is encouraging. Energy conservation "with existing technology" (insulation, regeneration, cogeneration and optimization with energy storage) has real immediate potential to substantially reduce energy dependence on fossil fuels and enable use of alternative and renewable energy sources. There are many diverse and abundant energy sources with promising future potentials, so that mankind should be able to enhance its activities, standard and quality of living, by diversifying energy sources, and by improving energy conversion and utilization efficiencies, while at the same time increasing safety and reducing environmental pollution.

III. Conclusion and Recommendation

We are in 'energy transition era' from fossil fuels to alternative (including nuclear) and renewable energy sources (including solar, biomass, hydro, wind, and geothermal). In this transitional era, the energy conservation (including energy storage) is the most "efficient" and thus the most viable option in initial and mid-range period, until alternative and renewable energy infrastructure is developed and matured

This energy initiative is not for pursuing any pragmatic research area, but to develop integrated activities and resources, with educational and outreach programs and a regional energy center for acquiring, optimizing and adapting advanced and innovative methods, devices and processes for energy production, utilization, optimization and management in residential, commercial, industrial and transportation sectors.

Considering global, national and regional challenges and potentials, we have a unique opportunity and responsibility to initiate, develop and sustain meaningful and profitable, diverse energy activities.

We should demonstrate with our curricular and research activities that "*we believe in and care about*" the sustainability, efficiency and conservation issues by leading and not falling behind regional, state, national and world-wide activities in these critical issues and promising opportunities for our graduates. It is our interest and responsibility to embrace and lead, and to prove that environmental sustainability, efficiency and conservation can pay dividends, not just for us but for others in our region and for future generations.

March 23, 2011

TO: Abhijit Gupta (ME PC Chair) and Simon Song (ME Chair)

From: Milivoje Kostic 

**RE: Kostic's 2010 Sabbatical Activities Report:
Addendum: Additional Explanations/Justifications**

As I have stated in my Sabbatical Report Summary, “*During my sabbatical semester many critical activities has been conducted and background research with specific outcomes completed. However, due to “ambitious” nature of the proposed objectives and temporary “recession” of suitable funding sources, an aggressive institutional collaboration and support are necessary for development of future funding.*” Among four tangible outcomes in the Sabbatical Proposal, two were completed (i) & (ii), and progress for the remaining two (iii) & (iv) has been made but could not be completed as justified below. Additional (to proposed) research has been also conducted with specific accomplishments, see below. Considering the “unique & global” institutional nature of my proposal, which has included development of critically lacking *energy/sustainability* initiatives and NIU infrastructure (renovations of existing building roofs and new green building landmark), the outcome of my activities may be judged (depending whether “wide or narrow view”) as successful in providing unique vision and specific initiatives, or deficient in developing funding for proposed institutional infrastructure, where the institutional support has been expected. In addition to my **Sabbatical Report** (*Summary* and specific *Initiatives/Proposals*, 5 pp) and **Supporting Documentation** (10 *Items*, 30 pp), the followings are my specific answers to your requests and additional explanations:

The tangible outcomes (quoted from *Sabbatical Proposal*):

(i) “... *development of critical activities at NIU as related to research area of the Department of Energy (DOE)'s Building Technologies Program (BTP), including collaboration with NIU personnel and external institutions*”:

Completed as stated in the Sabbatical Report and Supporting Documentation.

(ii) “... *development of related expertise and professional competence, including technical publications in the buildings' energy conservation area*”:

Completed as stated in the Sabbatical Report and Supporting Documentation.

(iii) “... *development of proposal(s), with objective to obtain funding for retrofitting existing buildings*”:

As stated in the Sabbatical Report and Supporting Documentation (*Item #1*¹), the activity has been initiated in August 2009 when funding was available (“*Recovery Act: Advance Energy Efficient Building Technologies*” solicitation, DE-FOA-0000115, Technical Subtopic 3.2. - August 2009). This was the main reason for inclusion of this unique opportunity into my Sabbatical proposal. However, by the time Sabbatical was approved and commenced the funding had expired and new sources could not be found in short period of time. I have tried to collaborate with the KFU and possibly get Saudi’s collaborative funding, and made progress in related proposal preparation with local *Thermalshell* company (*Item #2*). I have been trying hard to get NIU institutional support in May & Fall 2010 semester (*Items #4 to #9*), including possible collaboration with UIC-ERC (*Item #5*), and even smaller NSF-SBIR/STTR funding (*Item #8*); however, there have not been available suitable funding announcements for the proposed development of institutional energy-related infrastructure.

¹ *Item #s* refer to *Items* in the 30-page **SABBATICAL SUPPORTING DOCUMENTATIONS** accompanying Sabbatical Report

- (iv) “... to develop a proposal for funding of a model “Energy Efficient Building” on NIU Campus, which will integrate all available energy conservation practices and technologies with energy renewable sources, and may house interdisciplinary energy & environmental programs, including Master of Energy Science and Technology (MEST) program, to be developed. **Most of the above outcomes should be accomplished with proper collaboration and institutional support**”:

Similar to the proposed outcome (iii) above, and as stated in the Sabbatical Report and Supporting Documentation (Item #1), the funding was available (“Recovery Act: Advance Energy Efficient Building Technologies” - August 2009). This was the main reason for inclusion of this unique opportunity into my Sabbatical proposal. However, by the time Sabbatical was approved and commenced the funding had expired and new sources could not be found in short period of time. I have been trying hard to get NIU institutional support in May & Fall 2010 semester (Items #4 to #9), including possible collaboration with UIC-ERC (Item #5); however, there have not been suitable funding announcements available for the proposed development of institutional energy-related infrastructure.

During the sabbatical research and consultation with external experts (ERC and others, Item #5) it has been concluded that development of a Northern Illinois Regional Energy Center with focus on energy education and energy conservation, efficiency and sustainability, by integration of all available and new to be developed energy conservation practices and efficient technologies including renewable and sustainable energy resources, is much more suitable for funding than originally proposed landmark “Green Energy Building.” A background research is completed for development of unique, interdisciplinary Master of Energy Science and Technology (MEST) program (Item #3). The proposed interdisciplinary energy activities are more suited for NIU profile and the NI Region than any specific cutting-edge research proposal and, therefore, should be given due consideration and priority. There will be more need for quality energy education and energy-related jobs at all levels along with innovative and efficient energy technology development and applications, and NIU should be proactive and more aggressive participant and contributor to the regional, national and global needs (see also Item #10).

I have initiated work on a related manuscript, “Energy conservation, efficiency improvements, and use of renewable energy sources for economical and environmental sustainability.” It should result in a future publication.

The challenges for undertaking proposed activities in a semester time have been bigger than expected, but so are the potentials and opportunities for NIU. The activities and collaborations are commenced and continuing and if given due institutional priority and support, multiple future proposals are expected.

Additional (to proposed) research activities with specific accomplishments:

As opposed to my previous Sabbatical at Fermi Lab, this time, I have conducted my sabbatical activities “in-house” at NIU. In addition, I have been fully involved in conducting regular, on-going, collaborative funding research project with Argonne Lab and co-advising several graduate students working in CFD and nanofluid research areas, resulting in three MS Theses completion and three publications.

Publications:

1. Biswas, D., Lottes, S., Majumdar, P., and Kostic, M., *Development of an Analysis Methodology for Pressure Flow Scour under Flooded Bridge Decks Using Commercial CFD Software*, Proceedings of the ASME 2010 International Mechanical Engineering Congress & Exposition, IMECE2010-37198 (12 pp), November 12-18, 2010, Vancouver, British Columbia, Canada, ASME, New York, 2010.
2. Kostic, M. and Walleck, C., *Design of a Steady-State, Parallel-Plate Thermal Conductivity Apparatus for Nanofluids And Comparative Measurements With Transient HWTC Apparatus*, Proceedings of the ASME 2010 International Mechanical Engineering Congress & Exposition, IMECE2010-38187 (12 pp), November 12-18, 2010, Vancouver, British Columbia, Canada, ASME, New York, 2010.

3. Tulimilli, B. R., Majumdar, P., Kostic, M., and Lottes, S., *Development of CFD Simulation for 3-D Flooding Flows and Scouring Around Bridge Structures*, Proceedings of the 3rd WSEAS International Conference on URBAN PLANNING AND TRANSPORTATION (UPT '10), Corfu Island, Greece, July 22-24, 2010. In LATEST TRENDS on URBAN PLANNING and TRANSPORTATION (Editor: M. Jha), ISSN: 1792-4286; ISBN: 978-960-474-204-2, p. 129-135, WSEAS Press 2010.

Supervision of the following MS Theses:

- *Craig Netemeyer*, “Exploring Flow and Heat Transfer Characteristics of New Hybrid Polymer-Nanofluids,” M.S. Thesis. Department of Mechanical Engineering, In progress, 2010.
- *Phani Ganesh*, Development of a Three-Dimensional Iterative Methodology Using a Commercial CFD Code For Flow Scouring Around Bridge Piers, M.S. Thesis. Department of Mechanical Engineering, Completed in October 2010.
- *Vishnu Vardhan Reddy Pati*, “CFD Modeling and Analysis of Flow through Culverts, M.S. Thesis. Department of Mechanical Engineering,” M.S. Thesis. Department of Mechanical Engineering, Completed in October 2010.
- *Bhaskar Rao Tulimilli*, “Development of a Three-dimensional Scouring Methodology and its Implementation in Commercial CFD Code for Open Channel Flow Over a flooded Bridge Deck,” M.S. Thesis. Department of Mechanical Engineering, Completed in June 2010.

Work on fundamentally new theory, “Thermo-Mechanical Mass-Energy Transfer by Photon ‘On-Contact’ Propagation,” to be published:

It draw recent attention by a renowned research group, led by Chinese Academician ZY Guo <http://en.wikipedia.org/wiki/Zeng-Yuan_Guo>, who established a similar new, *Thermomass Theory* <http://en.wikipedia.org/wiki/Thermomass_Theory>. They have invited me to the prestigious “Beijing Thermal Forum” to present my innovative theory (abstract below) based on the existing well established observations and theories (Einstein mass-energy equivalence and thermal radiation heat transfer).

The International Forum on Frontier Theories of Thermal Science

December 19-20, 2011, Beijing, China

(By invitation only: about 25 world scientists with accomplished or promising *Frontier Theories of Thermal Science*)

Thermo-Mechanical Mass-Energy Transfer by Photon “On-Contact Propagation”
by Milivoje M. Kostic

Summary: *Based on atomic electron-shell interactions and the Einstein mass-energy equivalence, during “believed-massless” heat conduction or mechanical work transfer there has to be photon mass-energy propagation through involved material structures from a mass-energy source to a sink system.*

Abstract: It has not been explicitly established what are the fundamental mass-energy carriers for conduction heat or mechanical work transfer within material systems, but are both widely considered to be “massless.” Based on atomic electron-shell interactions and the Einstein mass-energy equivalence it is deduced here that during thermal heat conduction or mechanical energy transfer there must be underlying electromagnetic transfer, i.e. photon “on-contact propagation”, as well as corresponding mass-energy transfer carried by photons; otherwise the mass-energy equivalence will be violated. We may further conclude that any energy transfer must be accompanied by photon transfer, either as electromagnetic waves on-long range through space or “on-contact” within material structures, or as diffusion or motion of material structures, due to underlying photon mass-energy propagation from a mass-energy source to a sink system.

Continuous work in the challenging area of the Second Law of Thermodynamics with original contributions to be published:

Invited to present at the "Second Law of Thermodynamics: Status and Challenges" Symposium as part of the broader, *The 92nd Annual Meeting of the Pacific Division of the American Association for the Advancement of Science*, San Diego, CA, June 14-15, 2011. Invited by Daniel P. Sheehan, Professor of Physics (University of San Diego), Symposium Chairman and co-author of book, "*Challenges to The Second Law of Thermodynamics: Theory and Experiment (Fundamental Theories of Physics)*," Springer 2010, 347 pp.

*The Second Law of Energy Degradation and Entropy Generation:
Founded on Sadi Carnot's Ingenious Reasoning of Reversible Cycles*
by Milivoje M. Kostic

Abstract:

Sadi Carnot's ingenious reasoning of reversible cycles is in many ways equal to if not more significant than Einstein's relativity theory in modern times. It resulted in the so called *Carnot ratio* equality, $T/T_0=Q/Q_0$, that is much more important than what it appears at first. Actually, it is one amongst the most important equations in Thermodynamics and among the most important correlations in natural sciences. It led to discovery of Thermodynamic (absolute) temperature and entropy, and the far-reaching Second Law of Thermodynamics. No wonder that Carnot's work was not noticed at his time, when his subtle reasoning of ideal heat-engine reversible cycles is not fully recognized, and may be truly comprehended by a few, even now. Further reasoning and subtle deduction, thus proof, of the Clausius (in)equality are introduced and discussed, along with the generalization of the Second Law of entropy generation and energy degradation.

NOTE: Item #s above refer to Items in the 30-page SABBATICAL SUPPORTING DOCUMENTATIONS accompanying Sabbatical Report

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The challenges for undertaking proposed activities in a semester time have been bigger than expected, but so are the potentials and opportunities for NIU. The activities and collaborations are commenced and continuing and if given due institutional priority and support, multiple future proposals are expected.

The Sabbatical 2010 Semester has been the most intellectually challenging and productive for me.
