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The IPSI BgD Transactions on Advanced Research

Multi-, Inter-, and Trans-disciplinary Issues in Computer Science and Engineering

A publication of
IPSI Bgd Internet Research Society
New York, Frankfurt, Tokyo, Belgrade
July 2007 Volume 3 Number 2 (ISSN 1820-4511)

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The IPSI BgD Internet Research Society

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How to Ruin the Carrier of a Ph.D. Student: Precise Guidelines

Milutinović, Veljko; Tomažič, Sašo

IN our profession, one widely utilized Ph.D. work methodology implies the following steps, both when conducting the research and developments (before the work is completed), and when writing the thesis and papers (after the work is completed):

1) Introduction
2) Problem statement and why it is important
3) Existing solutions
4) Proposed solution that is both application and technology aware
5) Details
6) Conditions and assumptions
7) Mathematical analysis
8) Simulation analysis
9) Implementation analysis
10) Conclusion
11) Acknowledgements
12) References

Details of this methodology are elaborated in [Milutinovic2003]. One example of the use of this methodology is given in [Bush2008]. Working on each one of the above defined steps, Ph.D. students can undertake activities and create habits that could form irreversible damages to their research mentality and ruin forever the chances to become a real scientist in the future. The text to follow discusses the major pitfalls of each methodological step, using the following template: (a) Axiomatic statement, (b) Short explanation, and (c) Illustrative example, from real life of a Ph.D. student. The first template\element always has a negative connotation, the second one is typically neutral, and the third one is always positive (with a reference to a Nobel Laureate statement at VIPSI conferences).

1) Keep in mind that the Ph.D. thesis is the crown of a research carrier, and has to be a perfect piece of work, to be conducted for years, even decades; definitely not just a proof that a person is able to solve scientific problems using scientific methodologies, in conditions when the real research starts after the Ph.D. thesis is defended. It is the fact that many Ph.D. research activities, for a variety of reasons, take too long. At some universities, especially in East Europe, many researchers obtain the Ph.D. not long before they retire, which is a problem, as indicated by Nobel Laureate Ivo Andric.

2) Keep in mind that each problem has many elegant and simple easily understandable wrong solutions; select such a problem for your Ph.D. research. The approach is especially effective if one chooses a problem that is not important for the present day technology and applications. In real world, it is the responsibility of the Ph.D. thesis advisor that the student selects an important problem to work on, and the advisor, rather than a student, is to be blamed for missing directions, as indicated by Nobel Laureate de Gennes.

3) Keep in mind that one has to master all existing solutions to the problem before one makes an attempt to create something novel. Such an approach will definitely lead the student into directions not taken by others. It is well known that the Nobel Laureate Marconi discovered that short waives do bounce off the ionosphere, because he dared to do the related experiments in conditions when nobody else dared, because a guru of the field published a paper ‘proofing’ that something like that is not possible; the inventor did not know about all existing work in the field.

4) Keep in mind that educated newcomers into the field never create good new ideas; only experienced experts can create breakthrough ideas, by using a bottom-up approach (in technology related considerations) and an inside-out approach, developing the idea before thinking about its use (in application related considerations). Actually, the fact is that the accumulated knowledge (which may not be relevant any more) could create blocking obstacles in the process of our creative thinking and decision making. If one takes the bottom-up and usage-ignoring approach, one lacks wide views and fails the exam of time, as indicated by Nobel Laureate Arno Penzias.

5) Keep in mind that one should never share the details of an invention with others, because

Manuscript received January 13, 2007.
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they will steel it and abuse it. Some researchers do not go to conferences (time waste), and publish their work only in journals (that brings the SCI credit, which is typically a formal requirement for oral defense). The fact is that one obtains the best ideas when trying to explain the initial ideas to others, as pointed out in several keynotes of Nobel Laureate Jerome Friedman.

6) Keep in mind that wrong assumptions (obtained by oversimplification) will create good results. It is the fact that narrowing the assumptions and conditions of the research increases the probability that one creates something novel, but narrowing beyond the absurd line turns the underlying assumptions into wrong assumptions, since the contact with reality gets lost. If one lives 24 hours with the Ph.D. thesis problem, and is obsessed with it, one will create original solutions without introducing any technology and application restrictions, as in the case of the seminal discovery of Nobel Laureate Harold Kroto.

7) Keep simplifying the problem until it becomes solvable. By doing this, one typically creates a useless result. The right approach is to invest into the mathematics-oriented education, so complex issues are not a taboo any more, as proposed by Nobel Laureate Martin Perl.

8) Keep in mind that one does not have to be a good programmer, if doing a Ph.D. in computer science and engineering; software tools will do the necessary job. Some researchers advocate that the purpose of Ph.D. research is to create ideas, not programs. The fact is, however, that one has to touch and feel the problem (e.g., by mastering the programming related details), before being able to create an effective simulation environment, as indicated in the keynote of Nobel Laureate Robert Richardson.

9) Keep insisting on an ideal implementation, since academic implementations (those including bugs, errors, and stupidities of the un-experienced) are worthless. Actually, such implementations are the best enablers of extremely efficient market oriented industrial implementations. Trying is the best catalyst for breakthroughs, as stated by Nobel Laureate Herb Simon.

10) Keep obsessed only by price and performance; do not care for issues like availability, reliability, feasibility; they are of secondary importance. Actually, “abilities” are typically much more important in technology and application considerations, and notoriously omitted. Only holistic approaches and solutions they create will survive technology and application revolutions, as indicated by Nobel Laureate Kenneth Wilson.

11) In the case of sponsoring, give research money only to experienced professors, never to a Ph.D. student exclusively; only the advisor knows how to find the best use of that money. Ph.D. students who rely on the excusive guidance from the advisor will never become creators of breakthroughs. Some USA research sponsoring agencies do recognize the importance of this issue.

12) In the case of references, go after quantity, not quality, both when creating a list of references, and when publishing your own work (better have 300 rather than 3 references in your CV). Actually, in some of the best universities of the World, researchers are judged for promotion based on only the best 3 papers: in such conditions, a researcher with 300 papers on the CV is judged based on only 3 he/she selects, and is obviously handicapped in comparison with another researcher who created only 3 papers (all of them superb, because he/she did not care to waste time on non-breakthrough ideas). Some Japanese research sponsoring agencies did already adopt this view.

Stupid will never agree to exchange his brain with the brain of a genius (since he believes that his brain more valuable), which is so frequently true, especially in research communities.

Getting Good Ideas in Science and Engineering

Perl, L., Martin (1995 Nobel Laureate)

Abstract— ***Good ideas in science and engineering range from the improvement of an electronic device, to the development of a new medicine, to writing a new computer program for better data analysis, to achieving new understanding in a science. I have no certain prescriptions for how to get good ideas. I do have advice and illustrations of what has worked for myself and others. I have warnings about mistakes made by myself and others. I also warn that for every good idea expect five or ten or twenty bad ideas. I write about the need for helpful and skillful colleagues. My goal is to help the reader maintain a way of thinking and a way of carrying out their work that strengthens their creativity.***

1. *Creativity in Science and Engineering*

1.1. Constraints on Creativity

THIS is part of a presentation I made at the VIPSI-2007 JAPAN in Tokyo Conference, May 31 - June 3, 2007. My talk was entitled "Creativity in Science and Engineering ; Sometimes Easier, Sometimes Harder, Than You Expect". This paper contains the part of that talk on getting good ideas in science and engineering. Good ideas include a vast range: invention or improvement of an electronic device, development of a new medicine, achieving new understanding in a science, writing a new computer program for better data analysis and so forth [1]. I have advice and illustrations of what has worked, I have warning about mistakes made by others and myself. I write about the need for helpful and skillful colleagues. My goal is to help the reader maintain a way of thinking and a way of carrying out their work that strengthens their creativity.

I am writing from sixty years in the technical world, first as a chemical engineer, than as an equipment builder and experimenter in physics, mostly in elementary particle physics [2]. I have been an academic most of my life, but though friends and consulting I have also been able to be involved in Silicon Valley's engineering world.

Creativity is sought everywhere: in the arts, in entertainment, in business, in scholarship, in mathematics, in engineering, in medicine, in the social sciences, in the physical sciences [3,4]. Common elements in creativity are originality and imagination. Creativity carries feelings of wide ranging freedom to design and to invent and to dream. But in engineering and science creativity is useful only if it fits into the realities of the physical world.

There are four types of constraints on creativity in science and engineering: conforming with the laws of nature, conforming with observations and experimentation, feasibility, and practicality. These constraints are a challenge but also a pleasure. The pleasure is solving problems and learning about the physical world. It is a contest with nature. In a sense nature is an antagonist; nature is often complicated and nature's secrets are hidden. But nature is a fair antagonist, once a secret is unlocked, once a device or a process works, nature doesn't change the rules.

Well that is almost true, there are the intermittent failures that we all dread. My friend, Michael Godfrey, an expert in electronics and computers, told me recently about an intermittent failure in his computer's hardware. Everything he did temporarily improved the system but the intermittent always came back. After many hours he solved the problem, So on the bad technical days nature is not a fair antagonist.

1.2. The Constraint on Creativity by Physical Laws: Example of the Creation of Energy

Creativity in the sciences is constrained by the laws off nature. For example, a physics law is that energy cannot be created from nothing. Energy can be changed in its form, thus the chemical energy stored in gasoline is changed into the moving energy of the pistons in a gasoline engine. Also mass can be converted into energy as happens in radioactivity, in a nuclear reactor, in a fission bomb, and in a fusion bomb. Always energy must come from other energy or from the conversion of mass, this is summed up in the principle – conservation of energy plus mass.

Many apparently creative attempts to violate this principle have been made for centuries [5]. Some of these attempts use very complicated mechanical and electrical machines in which energy is fed into the machine from the outside, either because of the negligence of the builder or because of fraud. Take the ever recurring proposal for a carburetor that gives hundreds of miles per gallon of gasoline , there is not enough

Manuscript received January 23, 2007.

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chemical energy in a gallon to move an automobile hundreds of miles.

But suppose the accepted physical law is wrong. Here is a place for creativity, but dreaming about a violation of the law is not enough, creativity must be constrained by logic and knowledge. For example, sophisticated modern attempts to violate the conservation of energy plus mass principle often involve present understanding of empty space. Our quantum mechanics picture is that empty space is a mixture of virtual photons and other particles that perpetually move and appear and disappear, this is called the zero-point energy of empty space. But quantum mechanics also holds that zero-point energy cannot be converted into useable energy. Perhaps this tenet is wrong. A proposal to test this barrier to the conversion of zero point energy to useable energy requires a logical revision in basic quantum mechanics theory and experimental proof of the validity of this revision. Account must be taken of previous related experimentation and how extensions of the revised theory affect established experimental results [6].

1.3. Creativity May Not Require Basic Understanding of Biology or Chemistry or Physics if it is Base on Solid Observation, Trial-and-error and Experimentation

Throughout most of our history, material progress in ceramics, in metallurgy, in building materials, in agriculture, in hundreds of products was made by observation, trial-and-error and experimentation. The relevant basic science was unknown. Yet the technological and engineering advances were tremendously creative. Creativity in engineering does not require knowledge of basic science, but knowing the basic science is useful.

Creative engineering with little or no basic science knowledge depends upon the care used in observation and experimentation. About six years ago there was a good example in some research of my colleagues and myself. We decided to search in meteoroids that have fallen on the earth for a possible but hypothetical particle. These meteoroids come from the asteroids that orbit the sun in the vicinity of Jupiter. My speculation was that these hypothetical particles might be plentiful in asteroids. The search depended upon grinding up the meteoroid and suspending the powder in oil, the way pigment is suspended in paint. Broad and profound basic science exists on suspensions of powder in oil. But there was a problem in that that the basic science emphasizes pure powders, while the meteoroid powder is made up of a complicated mixture of different metals and metallic compounds. I went to the experts in fundamental colloid science but they didn’t like the problem, too messy. So we resorted to the old trial-and-error methods used for thousands of years in making suspensions in paints and dyes and inks and drugs. Finally our own experimentation and a suggestion from a lubrication engineer gave us a solution. We mixed in commercial motor oil since one of its properties is to keep in suspension the metal and metallic compounds that are produced by engine wear. It worked! Although we didn’t find the hypothetical particle. the development of the meteoroid powder suspension was pleasantly creative.

1.4. Feasibility and Practicality Constraints on Creativity

Feasibility and practicality are obvious constraints on engineering creativity. Think about the direct use of a nuclear reactor in transportation: automobiles, trains, airplanes, ships. It is not practical to put a nuclear reactor in an automobile or railroad locomotive, or airplane, the reactor is too large, too heavy, too expensive, with radiation shielding and safety problems. On the other hand a nuclear reactor in a ship is feasible and practical.

2. GETTING A GOOD IDEA

2.1. Expect Many More Bad Ideas Than Good Ideas

There is a hard truth about creativity in science and engineering. for every good idea, expect to have five or ten or twenty bad ideas: ideas that don’t work, ideas that are wrong because they violate the know laws of biology or chemistry or physics, ideas that are impractical, ideas that are useless.

Nikola Tesla [7] is an example of a genius engineer, inventor and physicist who conceived and developed bad as well great ideas. His greatest idea was developing alternating current technology, with the financial support of George Westinghouse he finally overcame Thomas Edison’s stubborn and ignorant championing of direct current power transmission. Tesla was able to visualize the phase concept in electric currents, something that often puzzles students these days in spite of marvelous computer graphics explanations. He proposed new ideas and inventions in much of the electrical world: motor and generator design, alternating current transmission, pre-radio wireless communication.

Yet Tesla was wrong in his monumental efforts to send large amounts of electrical power without wires from a transmitting antenna to a receiving antenna, over distances of hundreds of miles, even around the world. He seems to have had two conceptual errors. The electrical power radiated by a transmitting antenna spreads out as the distance from the antenna increases so that as the distance to the receiving antenna increases, a larger and larger receiving antenna is needed to pick up the power. This problem makes the concept impractical at low frequencies, the concept becomes practical at very high frequencies such as with microwave beams or lasers. Tesla's second error was the belief that a receiving antenna could pull in radios waves from an area much larger than the size of the antenna. I don't know how he made these errors, he knew so much.

2.2. Reducing the Frequency of Your Bad Ideas

The way to reduce your frequency of bad ideas is to try to make sure that you understand the physical laws and the neighboring technology relevant to your new idea. Colleagues, the literature, the Web can be of help. Sometimes you have to keep going until you are the expert on the idea and you discover the show-stopper.

2.3. Turning a Bad Idea Into a Good Idea

But don't kill the bad idea prematurely. A bad idea can evolve into a good idea. The evolution into a good idea can be a short process, turning a bug into a feature, quoting my colleague Eric Lee. Or the evolution from bad to good can be long and tortuous.

3. Required Skills and Temperament

3.1. Understand Your Skills and Temperament in Choosing Your Field

You must take account of your temperament and skills in choosing your technical field or science and your interests in that. Don't try to fit yourself into any particular image of what a scientist or an engineer should be [8]. But there are four basic skills you must have: mathematical competence, a good memory, a talent for visualization, and a powerful imagination.

3.2. Mathematical Competence

You must be competent in mathematics although you don't have to be a mathematical genius. I can do original calculations in many areas of physics: Newtonian mechanics, electromagnetism, fluid mechanics, quantum mechanics; but I cannot work in complicated and abstract mathematics, and so I am precluded from understanding string theory, perhaps that's a good thing. I speculate about new ideas in physics and about experiments that might be interesting but I don't work on experiments based on mathematical ideas that I don't understand. Thus my mathematical knowledge does limit the range of my experimental work, but so far I have found plenty of experiments that interest me. Summing up: moderate mathematical knowledge and ability is needed in engineering and science [9].

3.3. A Good Memory

A good memory is crucial, not only so that you can easily remember formulas and facts, but so that you can recall where you last read or heard something that you want to retrieve. Yes there is now Google, but Google is not enough.

I don't know if I will ever work again with colloidal suspensions of complicated minerals, but I remember much about our studies, the look and behavior of good versus bad suspensions. It is very useful to keep a detailed notebook containing notes photographs, graphs, problems, solutions.

3.4. Visualization

In engineering and scientific work it is crucial to be able to visualize ahead of time how the work could be accomplished [10]. The intended work might be the invention of a mechanical or electronic device, it might be the synthesis of a complicated molecule, it might be the design of an experiment to evaluate the efficacy of a new drug, it might be the modeling of how proteins fold and unfold. The range of visualization modes is large. In my research I make preliminary engineering sketches of the mechanical and optical parts of the proposed experiments. In my early days I used tracing paper and a T-square, now I usually use a computer program. But my electronics knowledge is primitive and I must depend on colleagues to visualize the best electronics to use.

Different kinds of work require different kinds of visualization. Spread sheets or flow charts may be best. Always, the importance of visualization is to find the best way to proceed and to avoid mistakes and to perhaps find alternative solutions and related good ideas. Visualization is much more than planning, it involves incorporating your knowledge and experience and intuition in thinking how the work will go. It is seeing ahead as broadly and deeply as you can.

3.5. Imagination

Imagination is the fourth crucial ability required to be creative in engineering and science, imagination with the constraints I wrote about at the beginning of this paper: known physical laws, correct observation and experimentation, feasibility, practicality. Begin with the far reaches of imagination at the science fiction level, then slowly apply reality constraints.

3.6. Laboratory Skills

An important question is the extent of your hands-on skills and laboratory skills[11].Are you good at working with tools, at building equipment, at running equipment – electronics, microscopes, telescopes… This is my strength. I am an experimenter in physics. because I like to work on equipment, because I am mechanically handy and because I get great pleasure when an experiment works. But hands-on skills do not have to be your strength. Isadore Rabi, who was my doctoral research supervisor at Columbia University in the 1950's had no hand-skills. His graduate students, all learning to be experimental physicists, used to say that it was important to keep Rabi's hands away from our equipment, otherwise he would surely break something. Yet

Rabi won a Nobel Prize for advancing experimental atomic physics. In choosing what you work on, evaluate the extent of your hands-on and laboratory skills.

4. Luck

The importance of good luck in engineering and science is much oversold [1]. There are the overworked examples: Alexander Flemings discovery of penicillin when mold settled into a Petri dish; Wilhelm Röentgen's discovery of X-rays when he found that there was an emission from cathode ray tubes that fogged covered photographic plates. However good luck is almost always related to priority. In Röentgen's example there were many physics laboratories using cathode ray tubes and photography, within a few years the discovery would have been made somewhere else.

On the other hand, it is very important to avoid bad luck, the basic avoidance principle is the same as being careful when crossing a freeway. In engineering and science most bad luck is caused by mistakes in calculation, mistakes in design, mistakes in measurements, mistakes in experiments. I have had bad luck, perhaps you have too, by going into a project that didn't smell quite right to me, but I kept hoping for the best.

5. Colleagues

5.1. The Lone Scientist and Inventor

There is the popular image of the creative scientist who works alone, an image particularly powerful in medicine [12]. There is Louis Pasteur inventing pasteurization and then Pasteur learning how to treat rabies while fighting off the ignorance of his medical world.

In engineering the myth of the lone inventor is harder to sustain. There is Charles Goodyear and his sister Harriet discovering the vulcanization of rubber. How to make rubber insensitive to temperature and solvents was an outstanding trial-and-error problem in Goodyear's time and the two of them had the advantage of knowing from the work of others what did not work.

5.2. Colleagues and Friends in Science and Engineering

Today every engineer and scientist is immersed in her or his technical community, a community with some colleagues, some friends and many competitors.

You can't know everything in your field and you don't have to know everything. In many areas of science it is getting harder and harder to have the time to do both experimental work and extensive computing and original theory. In addition most of us do not have all the skills required to be creative in our field. You may be skilled in visualization of mechanical design but have little skill in visualization of electronic design. You may have little experience and no interest in using computers for numerical simulation and modeling. The solution is to work with and depend on colleagues and friends.

5.3. Find Colleagues Who are Smarter Than You and Know More

I always look for colleagues who are smarter than I am and who know more than I do. The obvious advantages are she or he may be able to solve a problem that has a produced a dead end in your work, if they can't solve the problem they can point you in possible directions for solution, and they can help you expand the scope and variations of your work. Most important, smart and knowledgeable colleagues can save you lots of time.

5.4. Avoid Colleagues Who are Fast and Showy Talkers, in Fact, It is Best to Avoid Such People In General

Many engineering and science people like to be fast talkers and appear to be fast thinkers. These external qualities get mixed up with internal qualities indicating creativity. I have found no correlation in the engineers and scientists that I have known over sixty years. Some creative people are fast thinkers and fast talkers, some are slow to think and to talk. The problem in associating with fast thinkers and talkers is that they often interfere with the process of developing a good idea, particularly when one is turning a poor idea into a good idea.

Richard Feynman, the most famous physicist after Einstein, was a fast thinker and talker, ever eager to show off his brilliance.. I met Feynman half-a-dozen time. I found that for me he was inhibiting not inspiring.

6. The Art of Obsession in Engineering and Science

6.1. The Importance of Obsession

When you are imagining and visualizing an idea that you expect to be fruitful it is important to be obsessed with the idea. Think about the idea as much as possible, neglecting boyfriends, girlfriends, children, spouses. Obsession will bring immersion of your mind into all the aspects of the idea: what has been done on related ideas, compatibility with physical laws and mathematics and logic, feasibility, practicality, extensions, variations. As the work continues into reality whether it is building a prototype or beginning experiments, continue with the obsession.

6.2. When to Give Up the Obsession

The art of obsession includes knowing when to continue and knowing when to quit. Sometimes the development of a good idea runs into trouble: you run out of money or a competitor has a better product or better experimental results or you run up against a subtle violation of a physical law. Then drop the obsession quickly. I have seen many careers ruined by persisting with an obsession If it is a good idea it will be eventually revived. If it is a bad idea, good riddance.

ACKNOWLEDGMENT

I thank Professors Hironori A. Fujii and Veljko Milutinovic for inviting me to VIPSI-2007 JAPAN and for many stimulating conversations. I also greatly appreciate have learned a great deal from the speakers and attendees at this conference. This work was partially supported by Contract DE-AC02-76SF00515 with the U. S. Department of Energy.

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How Does Science Contribute to Peace

Friedman, I., Jerome (1990 Nobel Laureate)

A friend recently asked me whether I thought science contributed to peace. I thought about this question from the perspective of a scientist and educator, and it became clear to me that both of these great enterprises can make significant contributions to peace. This may seem paradoxical because the applications of science have made modern warfare so devastating. But I want to make an important distinction – the distinction between science and technology. The goal of science is to understand nature, whereas technology applies this scientific knowledge to satisfy the needs of society. From this viewpoint, I would assert that knowledge is morally good, whereas technologies can be good or bad, depending on their intended use. I think that we should never stop trying to understand nature, but that not all possible technologies or applications should be developed. Society should carefully control what technologies are developed, and the scientific community has a special responsibility to warn the public and policy makers about the dangerous implications of destructive technologies.

Next, I would like to discuss what constitutes peace. Peace is often defined as the absence of war. But, as His Holiness, the Dalai Lama, has said, “Peace, in the sense of the absence of war, is of little value to someone who is dying of hunger or cold. It will not remove the pain of torture inflicted on a prisoner of conscience. It does not comfort those who have lost their loved ones in floods caused by senseless deforestation in a neighboring country. Peace can only last where human rights are respected, where the people are fed, and where individuals and nations are free.” This sentiment is also expressed in the comment of the Reverend Martin Luther, Jr., who said, “True peace is not merely the absence of war, it is the presence of justice.”

Clearly, peace has many dimensions. It can only really exist when people have freedom, dignity and justice and are not subject to poverty, famine, disease and an inhospitable environment. While the issues of freedom, dignity and justice fall into the domain of the political system under which a nation lives, science and technology can make positive contributions to the living conditions of people throughout the world.

At the beginning of this new century, many problems beset the world. While not all human problems can be fixed by technology because of their political nature, many of them could be significantly alleviated by major technological innovations. I firmly believe that the mitigation of some of these problems will come from the knowledge and unexpected technologies emerging from scientific developments of the future. The challenges faced by science and technology are crucial as never before. They include the following:

* Improving the general health of the population, and in particular controlling the spread of infectious diseases, both old and new ones.

* Understanding ecological and environmental issues, providing guidance to policy makers in these areas and developing new technologies that abate or eliminate our environmental threats.

* Providing sufficient food for the rapidly growing population of the world. The world’s population is expected to grow to about 9 billion people by about 2050.

* Developing alternative sources of energy and substitutes for scarce natural resources. Energy is an especially challenging issue, because improving the standard of living of developing nations will require significant increases in their use of energy.

* Providing new technologies to enhance the quality of life of our citizens, while extending those benefits to regions and groups that have not yet shared in them.

Science has enormous promise for addressing these issues and improving the human condition. But this great promise will only be fully realized if science and technology are humanely applied and their benefits are shared across the world. Science and technology must be used by society with wisdom and humanity. The outstanding theoretical physicist and great humanitarian, Victor Weisskopf, said “ Society is based on two pillars, knowledge and compassion. Compassion without knowledge is ineffective. And knowledge without compassion is inhumane.”

Space Tether Technology – Verification in Space and Future

Fujii, A., Hironori; Watanabe, Takeo; Kusagaya, Tairo; Trivailo, M., Pavel

Abstract— ***Space verification of advantageous performance of tether technology is much demanding for space development. Two projects are introduced in this paper to verify the performance of space tether technology. A sounding rocket will be launched in the summer of 2009 to deploy a bare electro-dynamic tape tether having a length of 300m. The other project to verify the space tether technology is a small satellite to deploy a bare 25km electro-dynamic tape tether, and the launch is expected in 2013 with employing a new solid motor rocket. These verifications of tether technology will lead to a large numbers of applications of space tether technology and some future projects are also introduced.***

1. Verifications of Tether Technology in Space

THE space tether technology is indispensable in constructing and also maintaining large space structures, which are designed for future space development including the solar power satellite and deep space exploration. Tether technology has such many advantages as simple structure, compact package, very long lightweight structure, autonomous construction with little help of the astronauts, and also active electro-dynamic artificial driver. It is thus necessary for tether technology to verify in space those performances expected as elements of space structures.

A verification of tether technology will be conducted for an electro-dynamic tether (EDT) deployed from a sounding rocket, S520 as shown in Fig.1. The S520-25, 25th of S520, will be launched to an altitude of 300km (velocity about 0.5km/s) at a dawn in August of 2009 by ISAS/JAXA from Uchinoura site in Japan to southwest direction (Ref.1). The EDT is deployed to the flight direction in order to cross with the direction of the earth magnetic field by almost 45 degrees, which is not controlled but is measured by a magnetometer. The objective of the projects is to verify experimentally the performances of a bare EDT in space from both scientific and engineering aspects including 1) swift and high reliability deployment of long tether, 2) fast ignition of a hollow cathode to provide electricity to electro-dynamic tether, 3) demonstration of EDT in collection of electrons, 4) vilification of electron collection theories including OML (Orbit Motion Limit) theory, 5) atmospheric entry of tape tether, and 6) space robot motion control. The tether is a bare EDT, which is a reinforced aluminum with width 25mm and thickness 0.05mm, and the science experiments employs the Langmuir tube as a main measurement device. The tether will be deployed in its length through 300m in 120 seconds (Fig.2) in order to afford sufficient time periods for science experiments for about 300 seconds in space.

Figure 1: S520 Sounding rocket

The two objectives studied in this proposal are apparently two major indispensable technologies both in the scientific and engineering aspects and will play important roles in the course of space development. The present proposal is to verify the fundamental technology for such important tether applications as deployment and use of bare conductive tethers in space. The other of the two objectives of the present proposal is the scientific study to incorporate the conductive tether by employing an Aluminum bare tape tether. A conductive tether opens unique opportunities for science that are not limited to testing OML collection under orbital conditions and generating convenient electron beams. The project is a European/ American/ Australian/ Japanese International Campaign. Main

Manuscript received April 12, 2007.
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participants from Europe and USA are Juan R. Sanmartin (UPM), Erick J. van der Heide, Michiel Kruijff (D&U), John Williams (CSU), Charles Les Johnson, and George Khazanov (NASA/MSFC).

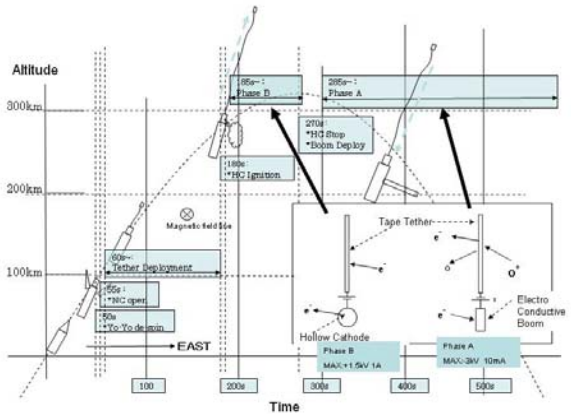

Figure 2: Experimental Sequence of the Sounding Rocket

The sounding rocket experiment could be extended to a low cost LEO mission of a small satellite with an electro-dynamic tether. These demonstrations will extend many useful methods of employment of the bare electro-dynamic tether including engine to increase/decrease orbit, supplier of electricity, spring-shot, and lifter for payloads. The objective is to verify the two fundamental and important aspects of the tether technology: One is a scientific experiment of the Alfven wave (Fig.3), and the other is an engineering demonstration to elevate and/or descend the orbit without using fuel as shown in Fig.4. A tether could generate controllable nonlinear Alfven wave fronts artificially in space and we can study many interesting physical features in relation to fronts of the solar wind with Earth, Jupiter, or comets. In the engineering mission, the electro-dynamic tether on space structures could apply thrust or drag without using any fuel mass, as well as achieving orbit elevation without any fuel, which could provide much effective and economic means for aerospace engineering.

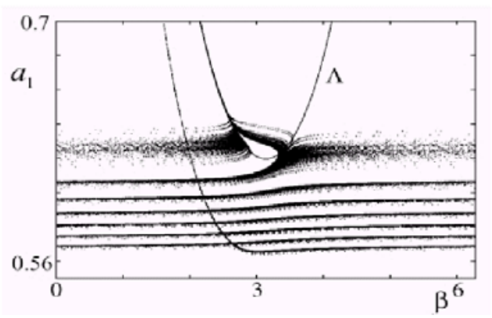

Figure 3: Nonlinear Alfven wave

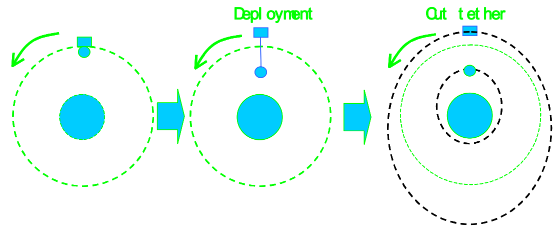

Figure 4: Orbit elevation/decent without fuel

2. APPLICATIONS OF SPACE TETHER TECHNOLOGY IN FUTURE

The drivers for the electro-dynamic tether are underlies in the low cost, simple mission concept, and fast realization possibility. The application includes a number of interesting and useful operations of space tether technology, including elevation of orbit of the International Space Station without consumption of, fuel and the solar power satellite.

The demonstration will also be very effective to examine the possibility of the rotating electro-dynamic tether to Jupiter mission application to enable simple entry into the atmosphere of Jupiter, or lunch free tour to Saturn satellites (Fig.5). It may be noted that de-orbiting of defunct satellites is indispensable for our future space missions to reduce the numbers of debris, and constitutes one of the main and relevant commercial applications of the technology. These demonstrations will extend many useful current applications of the bare electro-dynamic tether.

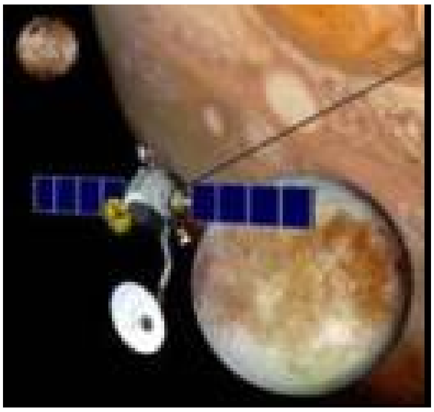

Figure 5: Lunch Free Tour Satellites

3. SUMMARY

The success of the two proposed international campaigns by Europe, United States, Australia and Japan on space tether experimental projects will herald a new era of the electro-dynamic tether technology to a number of innovative and useful space applications in our near future.

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Sonic Boom Alleviation for Next-Generation Supersonic Transport

Kubota, Hirotoshi

Abstract— ***A next-generation supersonic transport (SST) which is expected to be realized in near future has a strong impact on social capability through a high speed transportation and shall activate the industries as well as international cultural exchange. For accomplishment of the next-generation SST, the critical issues of technologies maturity, market viability and environmental acceptability should be overcome. Alleviation of sonic boom is one of the most critical issues as the environmental compatibility of the SST, therefore, sonic boom propagation analysis for boom acceptability assessment and low-boom / low-drag configuration design are presented in the present paper.***

Index Terms— ***Sonic boom, Supersonic airplane***

1. *Introduction*

A FORECAST of air traffic demand by JADC (Japan Aircraft Development Corporation) indicates that the RPK (Revenue Passenger Kilometer) in the world in 2026 will be 10,579 trillion which is approximately 2.5 times of the 2006's [1]. In order to satisfy this future passenger demand, many kinds of air traffic including high-speed and/or large amount of transportation are needed.

A supersonic transport (SST) is effective and important for high-speed transportation. Although the "Concorde" was firstly operated commercially in 1976, it was retired on 2003 due to deficiency of cost and environmental acceptability. However, development of the next-generation SST has been required for satisfaction of the above passenger demand on the basis of technology innovation through the lessons-learned with the "Concorde". If there is an SST which connects North America, Europe and Asia of dense population in 5 or 6 hours, it brings more benefit to the society [2].

In Japan, SJAC (The Society of Japanese Aerospace Companies, Inc.) and JAXA (Japan Aerospace Exploration Agency) have continued a feasibility study of the next-generation SST [2], [3] (Fig. 1).

It is recognized that the next-generation SST should be realized by overcoming the critical issues of technologies accomplishment, market viability and environmental compatibility. In this paper, sonic boom alleviation is focused as one of the critical environmental issues.

Figure 1: Image of the next-generation supersonic transport [3]

2. *Sonic Boom Research and Development*

A sonic boom is caused by the sudden pressure increase on the ground which is due to the shock waves by an airplane in supersonic flight. The shock waves generated by airplane accumulate into the so-called "N-wave" in the far-field during the propagation. The over-pressure of N-wave gives severe influence on the human beings and animals on the ground, therefore its reduction should be required.

Two approaches to sonic boom issues are considered: (1) Boom acceptability assessment with wave propagation study, and (2) Design of optimized airplane configuration with low-boom and low-drag character. Since the sonic boom regulation shall be defined by ICAO in future, it is necessary to accumulate the data and propose to international community [4].

2.1 Sonic Boom Propagation Analysis

The typical analysis code of sonic boom is the Thomas waveform parameter method [5]. In order to apply the wave propagation methods to estimate the pressure distribution on the ground for the actual airplane configuration, it is necessary to obtain the accurate near-field pressure data either by a wind tunnel test or by a computational fluid dynamics (CFD).

The waveform parameter method is based on the principle that pressure wave is constituted by the appropriate numbers of wave element and represented by the following set of equations as

$$\frac{dm_i}{dt} = c_1 m_i^2 + c_2 m_i \qquad (1)$$

$$\frac{d\Delta p_i}{dt} = \tfrac{1}{2} c_1 \Delta p_i \left(m_i + m_{i-1} \right) + c_2 \Delta p_i \qquad (2)$$

Manuscript received February 4, 2007.

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$$\frac{d\lambda_i}{dt} = -\tfrac{1}{2}c_1\left(\Delta p_i + \Delta p_{i-1}\right) - c_2 m_i \lambda_i \qquad (3)$$

where

$$c_1 = \frac{\gamma+1}{2\gamma}\frac{a_0}{p_0 c_n} \qquad (4)$$

$$c_2 = \tfrac{1}{2}\left(\frac{1}{p_0}\frac{d\rho_0}{dt} + \frac{3}{a_0}\frac{da_0}{dt} - \frac{2}{c_n}\frac{dc_n}{dt} - \frac{1}{A}\frac{dA}{dt}\right) \qquad (5)$$

and m_i is pressure gradient at the i-th region of wave, Δp_i is pressure difference over shock wave between the i-th and the (i-1)-th wave element and λ_i is time duration of the i-th wave element(= ΔT).The properties $p, \rho, t, a, A, c_n, \gamma$ are pressure, density, time, sound velocity, wave ray area, wave surface speed at normal direction and specific heat of air. Suffix 0 denotes the properties at surround of wave surface.

Kubota et al have continued the propagation analysis with use of Thomas waveform parameter method since 1990 [4]. Yamada calculated the far-field boom signature under the condition of Mach 2, angle of attack of 0 degree, airplane length of 66.7 m, flight altitude of 18.9 km with steady flight in no-wind, standard atmosphere [4].

As a flat-top type sonic boom signature is moderate to the response of human beings rather than the sharp N-shaped type [6], the trapezoidal (flat-top type) pressure distribution is applied at the near-field. It is found that, even for the flat top-type near-field pressure distribution, it is reduced to N-type far-field signature when its peak pressure is high (Fig.2). It means that the peak pressure at the near-field should be suppressed in lower level even if the wave form is non N-type.

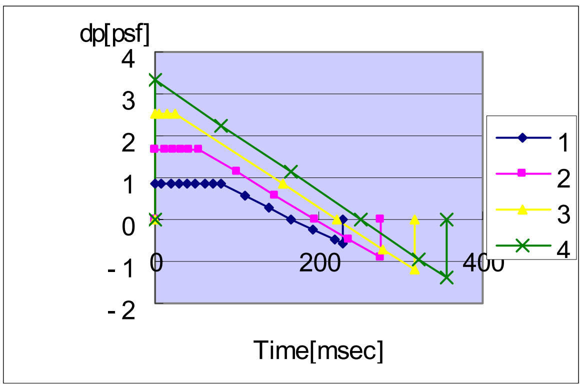


Fig. 2 Sonic boom signature calculated by Thomas waveforrm parameter method [4]

2.2 Low-boom / Low-drag Configuration Design

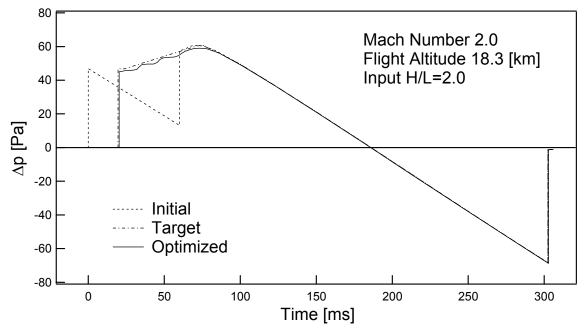
2.2.1 Optimization by Inverse Method

Makino, Kubota et al proposed the inverse method for the targeted ramp-type sonic boom signature with use of both of optimization theory and Thomas waveform parameter method and obtained the optimized fuselage configuration to generate the desired near-field pressure distribution. It is found that the change of fuselage shape can bring the desired boom signature [7].

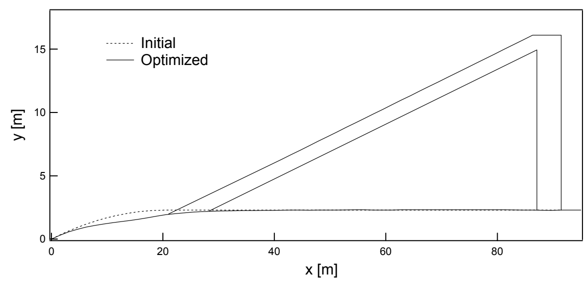
Makino et al also discussed the effects of non-axisymmetrical fuselage design for low-boom and low-drag for the application to a scaled supersonic experimental airplane program, NEXST with jet engine nacelle by JAXA [8].

2.2.2 Airplane Configuration with Oblique Wing

It is known that the oblique wing airplane can reduce the aerodynamic drag in supersonic flight. This shape also has a possibility to alleviate sonic boom. It is shown that the boom intensity can be reduced rather than the arrow wing of the same wing area by the wind tunnel experiment [9].



(a) Ground sonic boom signature



(b) Optimized fuselage configuration

Fig. 3 Optimized airplane configuration for sonic boom reduction [7]

3. Conclusion

The founding for sonic boom alleviation as one of the important environmental issues for accomplishment of the next-generation SST were presented on the standpoint of boom acceptability assessment with wave propagation study and design of optimized airplane configuration with low-boom and low-drag characteristics.

Those studies will surely contribute to realization of the next-generation SST. JAXA is starting a 5-years project of "Quiet Supersonic Airplane Technologies" in 2007 for sonic boom reduction to one half of the present.

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Mimesis –
The Scapegoat Model

Dumont, Jean - Baptiste

Abstract— ***Genetic Algorithm has already been applied to several optimization problems. For several years this heuristic has also been utilised in the field of design, and has proved to enable efficient, and moreover, original, and thus, innovative, results.***

Genetic Algorithms are usually based on two nature-inspired processes, mutation and recombination. Specifically, here, this work thus aspires to achieve innovation in a process of design evolution via the adoption of the format of an available, pre-existent cultural procedure: the scapegoating mechanism.

1. Back to Roots

WHY are human cultures permeated by sense and order? Cultures are symbolic systems possessing their unique codes. However, within these auto-integrated systems there always exist sense and social links, which posits the question of why cultures are always a vector of order, and not of chaos.

To answer such a complex question we must seek to identify the least common denominator of each culture. According to Girardian anthropology [1], in the earliest form of every cultural system there exists the universal ritual: that of 'sacrifice'.

How have human beings, mimetic animals, succeeded in co-habiting, considering that imitation engenders inherent rivalry and destructive violence? In effect, as mimesis results ultimately in universal conflict, the function of sacrifice is to replace the potentially multiple victims with a unique candidate: the 'scapegoat'.

In this procedure the 'scapegoat' becomes selected for sacrifice in order to purge social groups of their introspected violence. For this reason, 'scapegoats' are inevitably selected from a source as remote as possible from the selecting group.

The elimination, by the community in its entirety, acting in union, of the sacrificed individual both prevents any later revenge of the killing while breaking the circle of introspective violence which otherwise threatens the community. By these means the act of the sacrifice permits a rupture in the sequence of violent action and thereby grants a form of salvation to the group by occasioning a release from self-inflictive violent action by its substitution with an alternate, variant form of, - equally, and therefore fulfilling, - violent spending. Effectively, the inherent necessity for violence is transferred to a subject other than that of the group itself: it is no longer inter-acted, reflexively, but expressed. Sacrifice thus constitutes a cathartic function for the group.

During the mimetic crisis, the convergence of desires leads to reciprocal hatred, meanwhile the object of desire becomes veiled. More effective than strong differences between members of the community, this undifferentiated situation tends to radicalize the conflict. Each member is convinced in its uniqueness, but all are focusing their wills on the same object. Moreover, it inclines to the standardisation of the entire community. When the crisis reaches its paroxysm, the lack of differentiation inside the community becomes absolute and leads to the elimination of the scapegoat and to reconciliation.

In the animal world, the mimetic conflict already exists, but animals have an instinctive inhibition which prevents interactive slaughter merely in response to mimetic rivalries. Ethologists emphasize the domination-pattern effect: animals will stop fighting as soon as dominance is established. According to Girard, man is at once the most mimetic animal, and the less able to cope with his own violence. Hence, man had to elaborate a cultural response: the scapegoating mechanism.

Girardian anthropology posits that communities were universally generated by a founding, collective murder: based on a scapegoating mechanism. During the mimetic crisis, the entire community adopts the same imitation of an accusatory gesture toward the scapegoat which unites it, recovering a naïve and magical peace. This experience is thus a lived, sacred experience. The community will then attempt its re-iteration, with further ritual sacrifices, analogous to the original. It initiates the religious institutions. As cultural institutions come from religions (Durkheim), so do cultures arise from sacrifice.

The origins of cultures seem enshrined within this mechanism. Therefore, we should consider the Girardian hypothesis: each cultural order has been predicated upon a scapegoating mechanism.

Manuscript received January 27, 2007.
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2. Modeling a Scapegoating Mechanism

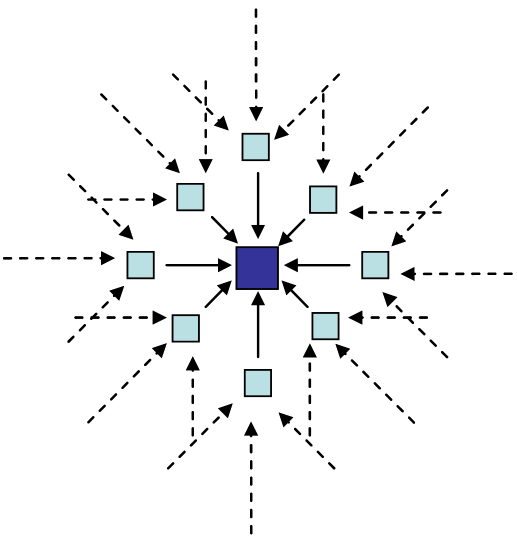
As we have described, in a community, the lack of differentiation within the community incites violence which is accumulated until an individual, who must be both inside the community and at the same time as remote from the community as possible, is discriminated to be designated as the scapegoat, and thus to be removed from the group.

Then, a model ought to be capable of providing a ranking of individuals according to the importance of the differences distinguishing them and the other members of the community. It should also take into account the fact that the more undifferentiated an individual, the more violent he is likely to become.

In our approach, let the community be represented as a set of n individuals. Inside this community, every individual is related with p other members of the group. The set of relations among the community is represented by the m matrix:

$$m_{i,j} = \begin{vmatrix} 1\,\text{if}\;\; j \text{ is related to } i \\ 0\;\text{otherwise} \end{vmatrix}$$

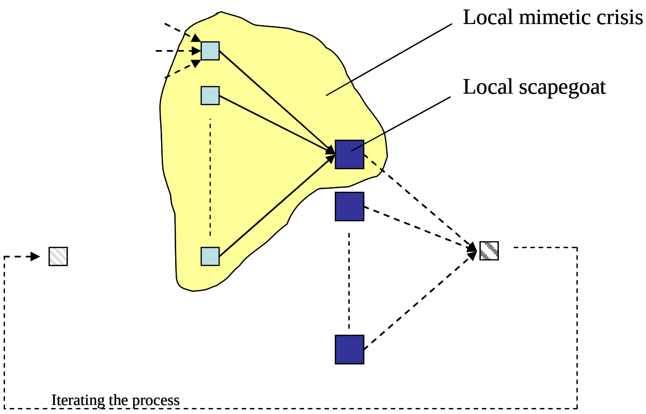
The number of relations for every individual is set to p. Then, every line of m is set randomly at the beginning of the simulation: every member is 'known' from other p individuals, but this relation may be not reciprocal. So m may be not symmetric.



At the beginning of the mimetic crisis, every individual may become the scapegoat as we are unable to evaluate their level of violence and differentiation. In our approach, to obtain more information about the community, every individual is initially the center of a virtual, local, mimetic crisis. At the end of that local crisis, by evaluating its intensity, we are able to quantify the degree of difference between each local scapegoat and the other p members to whom he is 'known'.

But, as we said, the more undifferentiated an individual is, then the more violent he likely to be. It must apply in every local crisis in which he is involved in our simulation. So we must iterate this process. Initially, each member has an identical potential of violence and of differentiation. As the first step, n local crisis infects the n members of the community. Then, with the evaluation of the potential of violence for every individual, we are able to estimate how differentiated an individual is. Then we simulate 'n' new local mimetic crises, taking into account the degree of differentiation of the individuals were inside their local group subsequent to the previous step. It grants us a revised level of violence for everyone, and by extension, of self-differentiation.

As we repeat this process we get a convergent value for the level of differentiation of every individual.



Let $d(u,u_i)$ the level of differentiation between individual u and individual u_i. Let $f(n,u)$ the level of differentiation for individual u at the beginning of the n^{th} local mimetic crisis.

We assume that f may be described as:

$$f(n,u) = \sum_{i=0}^{n-1} m_{u,u_i} \cdot d(u,u_i) \cdot \frac{1}{f(n-1,u_i)}$$

$$f(0,u) = 1 \quad \forall u$$

With d defined as a distance function.

It means for individual u_i that if u is 'known' from him, then the more u_i is lacking differentiation and the more he is different from u, the more he will transfer violence on u. With summing the contribution of every individual related to u, we have an estimation of the level of differentiation of u: the more violence u receives from others, the more u is differentiated from them.

Looking at what's happening to the whole community, let U_k defined by :

$$U_k = (f(k,u_j))_{0 \le j \le n-1}$$

Then, there is a recurrence relation between U_{k+1} and U_k:

$$U_{k+1} = F(U_k)$$

So, if our process is convergent, it converges towards a fixed point X for function F. Nevertheless, F doesn't seem a contracting function, at least at first sight, and it may not be easy to prove that U_k is convergent.

Fortunately, in our experiment k→f(2k,u) and k→f(2k+1,u) are always convergent. So our process is convergent and may give us a ranking of every individual inside the community based on their difference from others.

At the end of the process, the q most different individuals are designated as scapegoats and are removed from the community. To have a constant number of members for the community, they are replaced by q randomly generated individuals. It gives us a new generation for the community.

With repeating this experience, generation after generation, we managed to get our experimental results.

3. Experimental Results

We did two sets of experiments.

1st experiment

Our distance function d is there defined by:

$$d(x,y)=\sum_{k}\delta(x_k,y_k)$$

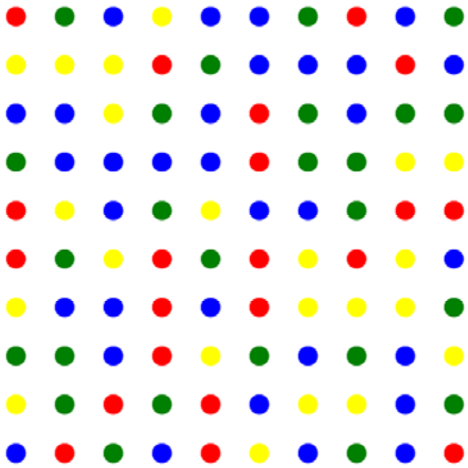
With:

$$\delta(x_k,y_k)=1 \quad if \ x_k = y_k$$

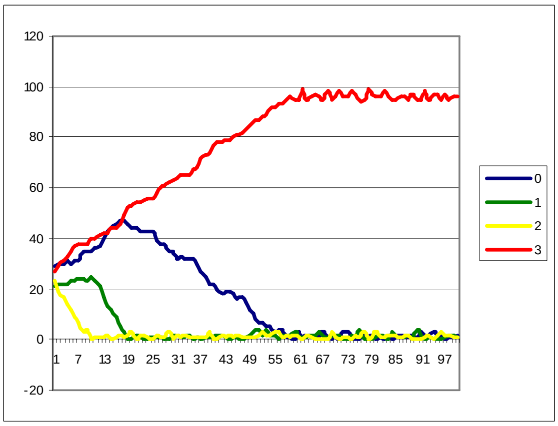
$$\delta(x_k,y_k)=0 \quad if \ x_k \neq y_k$$

There, the community was made of 100 individuals, all represented by a single value from 1 to 4. For an easier representation, we adopted a coloured circle to represent this character: 0 is blue colour, 1 is green, 2 is yellow and 3 is red. We used a community of 100 individuals. Every individual was related to 20 other members. At every round, 5 scapegoats were removed from the community using our model.

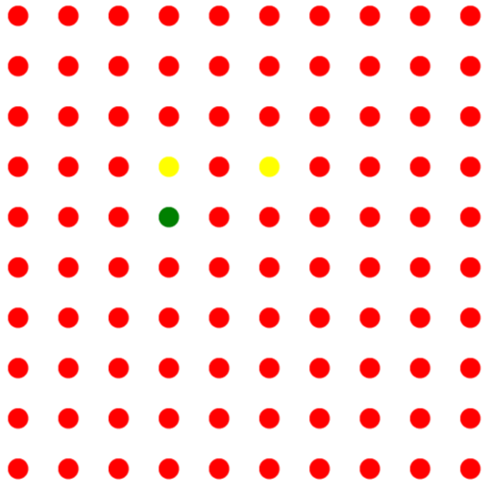
First generation (100 generations)



Initial Community



Removing using the scapegoat model



Final community using the scapegoat model

2nd experiment

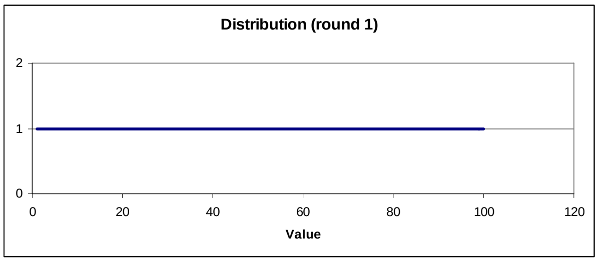
There, the community was made of 100 individuals, all represented by a single value from 1 to 100. Every individual was related to 20 other members.

Our distance function d was there defined by:

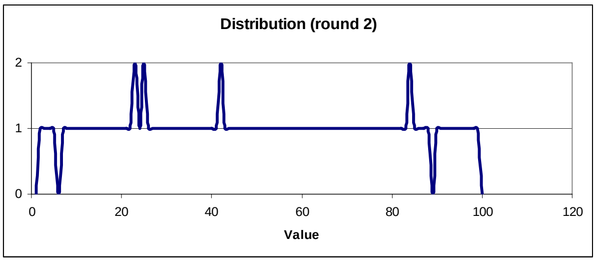
$$d(x,y)=|x-y|$$

At every round, 5 scapegoats were removed from the community using our model and replaced by randomly generated new individuals.

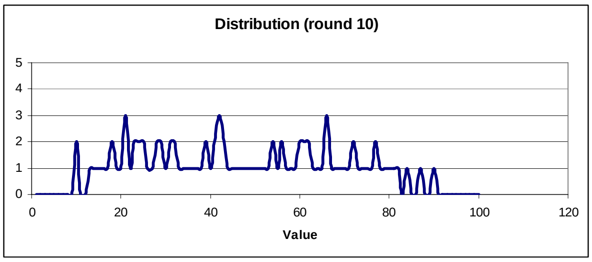
The first generation was based on an uniform distribution, that is to say that the i^{th} individual has i for value. For every value, from 1 to 100, there was only 1 individual with this value.

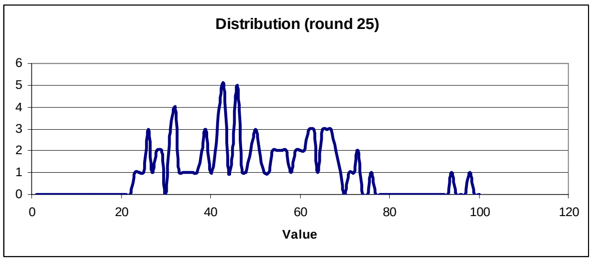


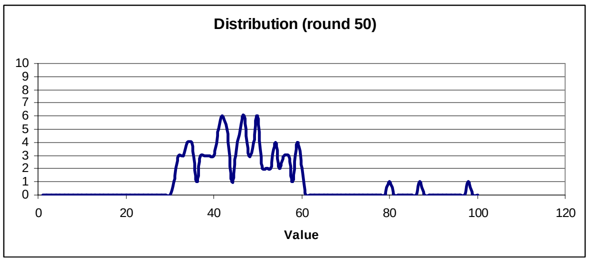
Then, 5 scapegoats were chosen by the community and replaced by 5 new individuals with random value. Here, for instance, one individual with the value 1 has been removed and, inside the new generation, there are now 0 individual with the value 1. Meanwhile, a randomly generated individual with the value 42 was born, there are now 2 individuals with the value 42.

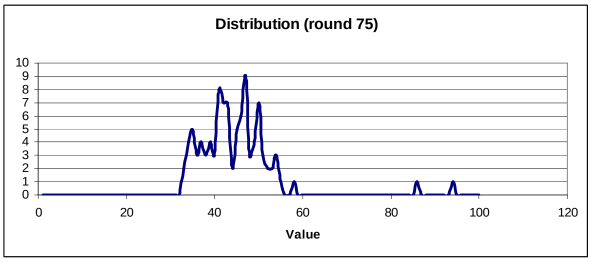


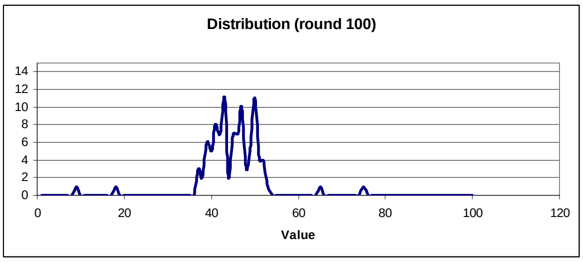
We repeated this process until the 100th generation.











4. Conclusion

Cultural evolution implies lots of conscious and unconscious processes inside the communities. The scapegoating mechanism may be the one which occurs initially. But there are lots of other ones which can be considered.

This model has been designed to be as simple as possible in order to be a didactic one, to illustrate the Girardian theory and to provide a new approach for genetic algorithms [2]. It could be ameliorated by using the other classical processes implied in genetic algorithm such as recombination or mutation.

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Analogy, Temporality, and Information In a Dynamic System

Jović, Franjo

Abstract— ***Tha nature of analogy in dynamic system: structure and function. Relation between classical and quantum information in dynamic systems. Holographic transformation of DNA as a final selfsimilar structure and its analogy to quantum system description. Temporality. Analogy between quantum and holography in dynamic systems: two experiments.***

Index Terms— ***structure coding, analogy failure, functional genomics, digital holography.***

1. *Introduction*

ANALOGY has been used since ancient times (Vitruvius) as a tool to enable and extend understanding. But its novel applications in functional genomics exhibit serious flaws [1]. Thus there is a question where are its limits in general such as in describing ontology in information theory, or whether truth can be revealed by using analogies on experimental data.

Vladimir Arnold states in an interview that mathematics is a part of physics where experiments are cheap. We can use analogy and extend this statement by putting that philosophy is a part of science where experiments are cheaper than in mathematics. Thus what is philosophy telling us about experiments, analogy, truth discovery and information that can be gained from an analogy?

Accoding to Ludwig Wittgenstein theory in science is intricately connected to language [2], introducing the cultural context of the scientist to any theoretical investigation. But according to Gianbattista Vico culture is directly connected to individual and collective myth(s) [3]. Taking each branch of science as a specific cultural medium one can only hypothesize how the information obtained from an analogy is projected to different branches of science.

Thus first of all we have to put forward the question of truth.

As stated by Martin Heidegger it is superflouos to hypothesize that something like truth exists [4]. If we exist, he puts, we exist in truth, we are ourselves and among the world the existing one, and the existence, which we are not, is discovered to us [4 ibid]. Thus our existence is connected by truth and it enables our path toward making assumptions (analogies). What governs this path? According to Heidegger the structure of essence of Dasein is based on temporality, enabling ontology [4, ibid pp 323].

How can temporality explain analogy failure in exact science?

By at least ignoring temporality!

I will first describe the nature of analogy in Part 2, then its failure in functional genomics in Part 3, and then discuss the relation between classical and quantum information in dynamic systems in Part 4. An analogy between digital holography and a near-holographic behavior of some dynamic system will be proposed in Part 5. A short discussion will be added as a summary of questions to be delt with in further investigations.

2. *Analogy*

By definition an analogy is the perception of similarity of two objects or processes based on similarity between the two in a subset of their traits, leading to the inference that if the two share some features, they will probably share (some) others [1].

An analogy can be used in many different ways tending finally to two extrema:

i) Functional identity, such as the case of two identical parts of DNA exhibiting functional equivalency

ii) Parable identity or surface superiority [5], such as the case of electromagnetic waves described as pairs of mechanical gears as given by Clark Maxwell; by not having a better analogy we are forced to „believe“ in such mechanical picture of the electromagnetics until now.

The theory of analogy has been investigated in cognitive science and resulted in gaining successful answers in broad terms but lacking in detailed answers between the existing theories and actual process models [5].

Similarities in meaning such as in the case of Maxwell model stem from similarities in mutual movements although the „gears“ in the case of electromagnetic wave are „growing“. Practically we do not know what is the essential structural part responsible for „growing gears“ in mechanical analogy of the electromagnetic wave.

Representation of the analogy should reconcile both the data retrieval and semantic mappings in the build-up of the analogy. The success of an

Manuscript received March 18, 2007.

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analogy can be measured by similarity metric derived from its linguistic environment (LSA, [5]), although insufficient for structural alignement in analogy [5]. Regarding the data processing in analogy one can not but observe its computational simlicity as compared to effectiveLSA analysis which is time consuming [6].

3. Critics of Functional Identity From a Complete Analogy

In order to obtain functional annotation contemporary biophysics generally attempts to relate chemical sequence to biological fittness using a doctrine of functional equivalence [1]. This doctrine seeks to write a linguistic construct from analogy sequence having a similar (or identical) chemical structure under the assumption that the two proteins with identical chemical structure have identical functions. Thus homologous proteins are assumed to have equivalent functions. This transfer of functional language is used in functional explanation of the new protein. But this has been found as a failure long before the genomics revolution [1].

The same is true for ortologs. Here the doctrine of homology that implies equivalency is restricted to a subset of homologs that diverged in the most recent common ancestor of two species sharing the homologs. But by axiom two species living in the same space cannot have identical survival strategies. This implies that two ortologous proteins might not contribute to functional fitness in exactly the same way in two species inducing the temporality as a factor.

As found in the leptin gene, responsible for obesity in mouse, the episode of evolution involved many nonsynonymous substitutions in the gene thus making it a false ortolog for humans and inducing the problem of nonlocality in genes.

Thus a complete analogy is sometimes a false functional identity.

4. Classical and Quantum Structure of Information In a Dynamic System

Classical measure of information is based on probability and informational entropy of codes associated to each state of a dynamic system. Such measure expresses structural variability of a system. The state of biological system can be expressed as a linear combination of base state in a Hilbert space [7]. The quantum measure thus obtained expresses a functional variability. Hereby quantum variablity measure relates to the function between states because it continually measures neighbouring state distances [7].

When isomorphysm exists between states of matter and states (codes) of information we can understand new ways to characterize and measure system information as well according to its states of matter [8]. The question arrises about the type of isomorphysms for dynamic system described with d variables. Approximation(s) of isomorphysm(s) can be sometimes given by sums of functions that depend on groups of just a few variables up to a given number k, k<<d [9].

Two systems are therefore tractable iff their corresponding differential equations show the same basic features in their phase space. Tractability means that we can compute an ε-approximation by using $n(\varepsilon, d)$ function values, where $n(\varepsilon, d)$ depends polynomially on ε^{-1} and d [9]. Hereby strong tractability means that $n(\varepsilon, d)$ is independent on d and polynomially dependent on ε^{-1}. Usually there is no isomorhysm between state of matter and state of information or at least we do not know how to numerically code the basic material element such as a DNA base [10]. Then the isomorhysm is at least binary intractable, meaning that for one information state there are many possible outcomes depending on process temporary coding.

On the other side the unmeasurability of absolute phase of electromagnetic wave leads the quantum model to partition ensemble falacy (PEF) [11]. This unobservability includes equivalency (UIE) for small phase differences in incoherent dynamic systems. Any attempt of such dynamic world model based on such fact is governed by this phenomenon, that is

$$UIE > PEF \qquad (4.1)$$

The other question is what about a coherent world assumption.

5. Information In a Coherent Dynamic System

There exists an opinion given by Hameroff and Rasmussen that coherent signals flow in neurons and their cytoskeletal networks [12]. These signals exhibit non-local connections in time and space ubiquitous to time evolution of spatially extended dynamic systems in nature. Such systems have selfsimilar fractal geometry [12]. Selfsimilarity implies that subunits of a system resemble the whole in shape. On the smallest scale measure such a dynamic system is also a DNA. If it behaves coherently then a near holographic structural behavior is at the core of the dynamic system.

By relaxing a DNA using digital holography one can analyse the resulting DNA hologram and later return back its content to the reconstructed DNA by means of inverse holography [10].

Experiments on small parts of digitaly coded DNA of the Esch. coli have shown that even the smallest changes in any part of the DNA can produce observable changes in hologram differences thus implying that any change of any part of a DNA can be a significant one.

Experiments with coherent electromagnetic excitation of seed grain have shown increase in grain vitality by increasing sprouting and greenes of plants [13].

6. Discussion

It seems that temporality is a main clue in analysing complex changes in dynamic systems. These systems can be living beings with their complex DNA structures. Involving temporality through analogy cannot be applied in a direct way like in classical dynamic systems. It is mandatory to include even the smallest changes developed during the time progress and incorporated in functional changes in a weird quantal way.

The simplest possible analogy of such approximation is the holography concept of a dynamic system because it violates the insensitivity of the tractability in classical dynamic system. But here some questions remain to be answered:

- how to code elemental structural components such as expressing DNA bases in quantitative way; basically we have used the Gaussian distribution function because of its rich information content?

- how can we start studying a basic living structure: as a hologram, as its inverse or as both at the same time?

- how to use the digital holography – as a complete transformation or as a partial one – we have used only amplitude holograms and completely avoided its phase parts?

- how to imagine system relaxations: we have supposed that the whole dynamic system relaxes at one time – the other authors like Hameroff have supposed only serial relaxations although extremely fast; our experiments with seed grains exposed to laser beam of very low power (1-5 mW) have exhibited significant changes in seed behavior [13].

Acknowledgment

Author is grateful to the Ministry of Science Education and Sport of the Republic of Croatia for financial support of the investigations.

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Structural Modelling and Consumer-Driven Decisions: a New Synthesis to Put Content Into the Structure

Badredine, Hala; Moskowitz, Howard

Abstract— ***This paper presents a new way to understand relations between variables. The paper combines two methods, structural equation modelling and experimental design of ideas. The objective is to first reveal relations between variables through the structural modelling (i.e., what the system is or does), and then identify in a deeper fashion the relation between two variables that structural model reveals to be linked together. The paper thus synthesizes two well-investigated areas into a new combination, mixing high tech (structural modelling) with high touch (experimental design of ideas). The paper outlines the approach using electronic health records as an illustrative example.***

I. Introduction – Structural Modelling and Bare-Boned Relations Between Variables

STRUCTURAL equation modelling (SEM) enables research to answer a set of correlated research questions by means of a single, systematic and comprehensive analysis. This is done by modelling the relations among multiple dependent and independent constructs in a simultaneous rather than a sequential fashion. Simultaneity in analysis differs profoundly from most linear and thus sequential approaches, namely the regression-based approaches such as analysis of variance, linear regression, and the like.

Structural equation modelling and regression techniques such as LISREL and partial least squares (PLS) and (AMOS) are second generation data analysis techniques that can be used to test the extent to which the structure of the relations among variables is correct. The literature behind structural equation modelling is well worked out, and now available on many personal computers, as a statistical package (e.g., Anderson & Gerbing, 1988)

The literature using structural models focuses primarily on the interrelations between variables. For example, with a structural model one can create a coherent 'structure' that allows one to test specific hypothesis. For example, in some of the work presented by the senior author (HB) on the adoption of electronic health records (EHR). one of the hypotheses is that Individual Organisational Characteristics will have shared correlation matrix impact on the usefulness of EHR (electronic health care records). To exemplify this approach consider the structure in Figure 1. Structural equation modeling will use the correlations to identify these general relations. Looking at the statement of the hypothesis we see only a relation between variables. We have no idea from the representation of the model, or from the mathematics of SEM how an independent variable can be changed to produce a desired change in the dependent variable. That is the SEM approach is content-free, and only looks for structure.

Hypothesis to be tested by structural modeling: Individual Characteristics, Individual Organizational Characteristics, General Attitudes and Usefulness of EHR will have shared correlation matrix impact on AIU- EHR

AIU-EHR: The actual individual usage of EHR. It is defined as the average time each EHR function is used per week by the specific personnel in charge if the EHR system is used.

Individual characteristics: It is defined as the cognitive structure of every department manager (CS)

Attitudes: It is defined as The General Attitudes of each manager (GA)
General Attitudes to EHR (GA)

Individual Organizational : It is defined as the years spent by a manager in an organisation (Yrs)

Usefulness of EHR: It is defined as attitudes towards contribution. (AC)
Attitudes to EHR Contribution (AC)

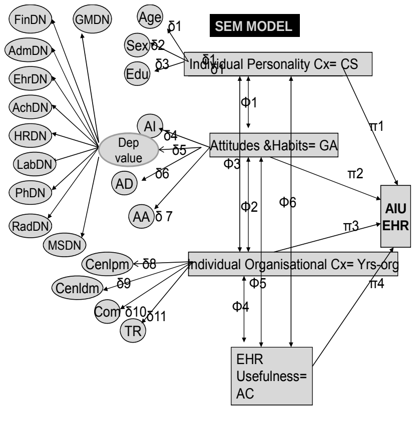

Figure 1: An example of different variables related to each other by structural Equation modeling, and the graph of this model. Note that SEM looks only at structure, not at content within the structure

Manuscript received March 14, 2007.
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2. ADDING CONTENT TO STRUCTURE OR "HIGH TOUCH" TO "HIGH TECH"

Despite the ability of structural modeling to explicate and confirm compound relations among variables, the models miss the richness of content that might be added by a professional, albeit perhaps in descriptive fashion. We know that variables behave in a way to suggest relations, and that the correlation matrix may suggest intervening variables that can be hypothesized to 'make relations work out'. What we miss, however, are words and phrases that give some type of vitality and 'realness' to the nodes on the structural model. That is, looking at Figure 1 (the structural model) we see that certain variables are related to each other, yet we don't really sense any of the descriptive richness that provides more meaning to the model. Of course, using many different Likert scales to generate a single variable in Figure 1 could add some of the meaning. The researcher would have to abstract the meaning from the anchor points on Likert scales and the scores on these scales.

Let's move in a different direction, going beyond the bare-bones structural model shown in Figure 1. Let's assume that the model is correct. Let's now flesh out the model. The question is how. The rest of this note deals with an approach based in experimental psychology (stimulus-response) and in statistical design of experiments (so-called conjoint analysis).

Our basic goal in this part of the paper is to identify richer language for each variable in the model, so that the structure we develop has more meaning that simply showing the existence of relations. We illustrate the approach by looking closely at two variables that are connected in Figure 1. These are attitudes and habits as one variable versus the perceived usefulness of EHR as the other variable. How can we flesh out relation of these variables to each other in a way that lets the researcher create desired changes in the dependent variable by systematically varying the content of the independent variable?

3. THINKING IN THE MODE OF STIMULUS-RESPONSE (S-R) AND EXPERIMENTAL CAUSATION

Let us focus on the perceived interest in EHR as driven by two sets of variables – the respondent's attitudes and habits on the one end, and the perceived usefulness of EHR on the other. We know that attitudes and usefulness are related to each other, but we really need to have a more profound sense of how they interact to drive a response such as interest in HER (see Anderson, 1970). Notice that we are moving here from establishing the existence of co-varying aspects to understanding what drives the professional's mind. We move from the sociological and statistical approach of establishing structure to the psychological approach of establishing content or simply what specifically can one say to drive the response..

To understand the mind we move from the world of correlations between variables to the world of experimentation and causation. Rather than using the research to establish that there exists a structure, we are going to use experimental design to establish part of the structure (Moskowitz, German & Saguy, 2005). The outcome will be a causative model. That is, we will be able to plug in some variables and estimate the response to those variables. We will plug in statements about attitude toward medical care, and attitudes towards EHR and come out with a prediction of 'how well this describes today's health care reality'. Our experimentation will thus add another dimension to structural model – filling in the deeper structure of the mind at each of the nodal points.

The 'how' in the S-R approach is straightforward. We I create different elements to describe the current state EHR from the point of view of description of what EHR is/does, and statements about how professionals respond to EHR. These are our independent variables. We want to learn whether a medical professional or a consumer, reading these elements combined into vignettes (independent variable) will be excited about EHR or just indifferent to it (dependent variable). This response is our dependent variable. Note that in the typical SEM model there is only a linkage and a correlation. Conventional SEM modelling does not drive the relation further, beyond description, to structural causality and engineering control. Hence the synthesis here.

4. STEPS IN THE "HIGH TOUCH" – HOW INFORMATION ABOUT EHR MIGHT CAUSE INTEREST IN IT

Our experiment to 'flesh out' the structural model uses experimental design of ideas (Box, Hunter & Hunter, 1978), also known as conjoint measurement (Luce & Tukey; Moskowitz, Porretta & Silcher, 2005; Wittink, Vriens & Burhenne, 1994). Our goal here is to understand how the specific elements of 'attitude' and response to EHR drive the response of 'How do you feel about EHR based upon what you just read?'. Even if the respondents cannot rationally deal with individual items as describing health care reality, they can intuitively respond to combinations of elements. These elements, in turn, interact with each other to drive the response, and from regression analysis we will see what elements are most critical.

Step 1 – Create a matrix of ideas to flesh out the specific variables. The ideas are simple, stand-alone phrases. They will be later combined into vignettes or test concepts. Table 1 shows the four silos (A-D) and the three elements in each silo. These phrases add texture and dimensionality to the variables of attitudes and responses to EHR.

Code	Element	Utility
	Additive constant	**26**
	Silo A - EHR from the viewpoint of the health provider	
A1	EHR makes the health care job easier	6
A2	EHR. makes hospital services more efficient	9
A3	HER Increases the quality of care given to patients	8
	Silo B - Outcomes of EHR from an economic view:	
B1	EHR makes hospital administration cost efficient	5
B2	EHR makes patient care quality and cost efficient	6
B3	EHR solves many problems..but will create many new ones	-4
	Silo C- Attitudes: Resistance vs acceptance of EHR:	
C1	Studies suggest that in quite a number of cases physicians still resist EHR	-3
C2	Studies reveal that older physicians tend to resist EHR than younger physicians	2
C3	Studies suggest that EHR is accepted more readily by those with more education	4
	Silo D - how the industry perceives EHR:	
D1	EHR will be accepted when the industry and the market are ready… trend reports suggest this will be fairly soon	7
D2	EHR will be accepted when the government recommends it	6
D3	EHR will be accepted when the hospital or organization decision makers finally agree to it	5

TABLE 1 – LIST OF SILOS AND ELEMENTS, AS WELL AS DATA FROM A SMALL PANEL OF RESPONDENTS WHO PARTICIPATED. DATA FOR ILLUSTRATIVE PURPOSES ONLY.

Step 2 – Invite people to participate, and introduce the project. Figure 2 shows an example of the introduction or orientation page.

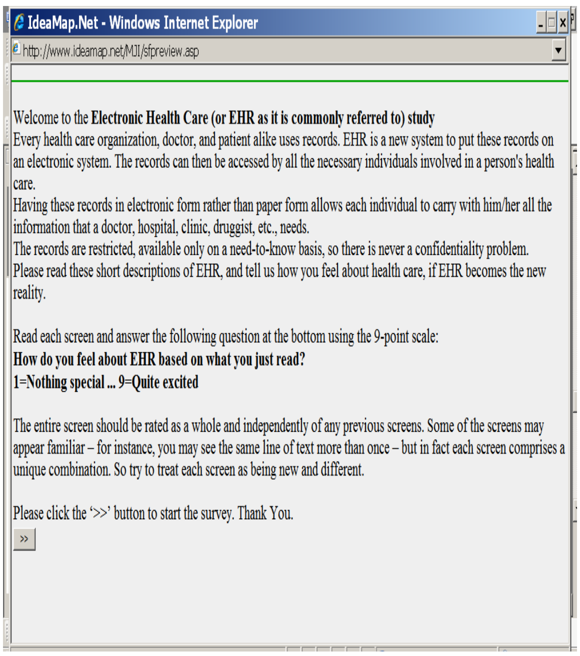

Figure 2: Orientation Page

Step 3 - Mix and. match these elements into small, easy to read combinations (test concepts or vignettes). These represent small communication pieces about the state of the medical profession, with specific focus on EHR. Figure 3 shows an example of a test combination. Present different combinations of these vignettes to respondents, get ratings. This step is done entirely by computer, which does all the relevant mixing/matching to create the vignettes, presents the stimuli, acquires the data and does immediate data processing. The combinations are created by experimental design, allowing for regression modelling (e.g., ordinary least squares).

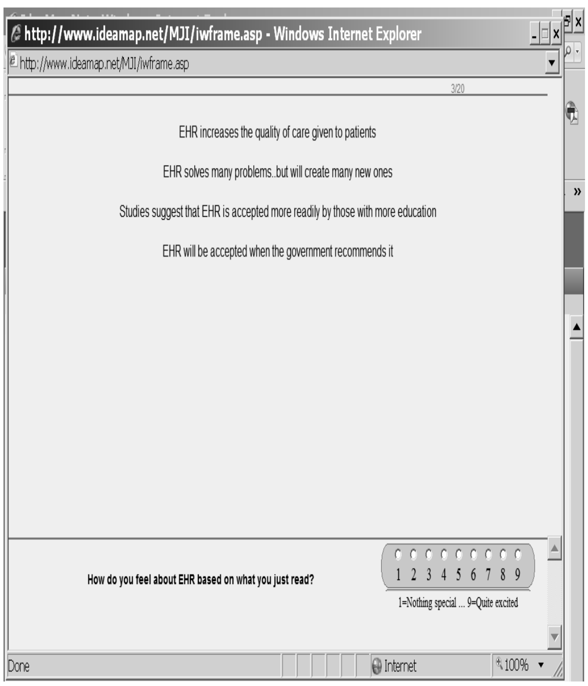

Figure 3: Example of a test concept and the rating scale

Step 4 – Using ordinary least-squares regression analysis, relate the presence/absence of the elements to the rating (How do you feel a bout EHR based on what your just read?). Create this model for each respondent. It is here that the content is added. The original SEM had suggest a relation between information and response of professionals. Now we know a more precise relation between specific information and the magnitude of the response.

Step 5 – Use the results of the model to show how each individual element describes the health care reality. We see a demonstration of this database in Table 1 above, on the right hand column. The additive constant shows the proportion of respondents who are excited by HER, either basically (additive constant), or as a function of the message.

In this case we have an additive constant of 26, meaning that 26% of the respondents are basically interested in what EHR has to provide, even without any elements.

There are many positive elements that add to this excitement. One element in particular adds an additional 9%. This element is EHR .makes hospital services more efficient. Some elements, however, diminish excitement. Here is one element that reduces excitement so that 4% fewer respondents are excited, i.e., a negative utility: EHR solves many problems..but will create many new ones.

Step 6 – The utility values can be added to the constant to come up with an expected percent of the respondents who would be excited by EHR. The sums (constant + up to 4 elements, one per silo) have ratio properties. That is, a sum of 56 represents 56% of the respondents, which is twice as much as a sum of 28.

5. *Discussion*

Traditional structural modelling, like traditional regression analysis, uncovers a set of relations that we might consider to be ‘bare bones’. We know what variables relate to each other from Figure 1, but in reality we have no sense of what these variables are about, or how strongly they relate to each other. In a sense Figure 1 shows the architecture, but without content.

We are looking at the architectural plan in Figure 1. This paper shows how that plan can be used by the interior designer, to add vibrancy and life to the plan. Carrying the metaphor a bit further, we can say that structural modelling provides the general architectural plan, but the infinite variety within that plan can better be done by studies using experimental design of ideas (see Moskowitz & Gofman, 2007).

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Heat Equation with Concentrated Capacity and Constant Coefficients

Jovanović, S., Boško; Jovanović, M., Irena

Abstract-*In this paper, Dirichlet's initial-boundary value problem for the one-dimensional heat equation with concentrated capacity is considered. Eigenvalues and eigenfunctions of the corresponding spectral problem are developed for two different specific cases.*

Index Terms—*conjugation conditions, eigen-functions, eigenvalues, parabolic equations, spectral problems*

1. Introduction

LET us consider the heat equation with concen-trated capacity at interior point $x = \xi$:

$$\left[1+K\delta(x-\xi)\right]\frac{\partial u}{\partial t}=\frac{\partial^2 u}{\partial x^2}+f(x,t),\quad (x,t)\in(0,1)\times(0,T),\ (1)$$

with the initial value:

$$u(x,0)=u_0(x),\quad x\in(0,1),\quad (2)$$

and Dirichlet's boundary conditions:

$$u(0,t)=u(1,t)=0,\quad 0<t<T,\quad (3)$$

where $K>0$ and $\delta(x)$ is the Dirac's distribution. This problem models the heat conduction process for slim leaf with an extremely large heat capacity (see [3]). An analogous problem is considered in the paper [2].

For $(x,t)\in(0,\xi)\times(0,T)$ and $(x,t)\in(\xi,1)\times(0,T)$, the problem (1), (2), (3) can be written in the form:

$$\frac{\partial u}{\partial t}=\frac{\partial^2 u}{\partial x^2}+f(x,t),\ x\in(0,\xi)\cup(\xi,1),\quad t\in(0,T),\ .$$

If it is supposed that the solution is continuous on the whole interval (0,1) and if rules for differentiation of distributions are used [5], one can obtain that conditions of conjugation at point $x=\xi$ are:

$$[u]_{x=\xi}=u(\xi+0,t)-u(\xi-0,t)=0$$

$$\left[\frac{\partial u}{\partial x}\right]_{x=\xi}=K\frac{\partial u(\xi,t)}{\partial t}$$

If one puts: $H=L_2(0,1)$, $Au=-\dfrac{\partial^2 u}{\partial x^2}$, and $Bu=\left[1+K\delta(x-\xi)\right]u$, it can be easily verified that the boundary problem (1) – (3) can be expressed as an abstract Cauchy problem:

$$\boxed{B\frac{du}{dt}+Au=f(t),\quad 0<t<T,\quad u(0)=u_0}\ .$$

where u_0 is the given element from H_B, $f(t)\in L_2\left((0,T),H_{A^{-1}}\right)$ and $u(t)$ is the unknown function which transforms $(0,T)$ to H_A; H_A is the energy space defined in the usual way, with inner product $(u,v)_A = (Au,v)$. One can define H_B and $H_{A^{-1}}$ analogously (more about Hilbert spaces in [6] and [7]).

2. The Corresponding Spectral Problem

The solution of the classical initial-boundary value problem for heat equation can be expressed (see [4]) as a Fourier's series of corresponding spectral problem's eigenfunctions. In our case, that spectral problem is (see [1]):

$$\boxed{A\omega=\lambda B\omega}\ .$$

Returning to original denotations, one obtains:

$$-\frac{d^2\omega}{dx^2}=\lambda\left[1+K\delta(x-\xi)\right]\omega(x),\quad x\in(0,1)$$

$$\omega(0)=\omega(1)=0\ ,$$

or:

Manuscript received April 30, 2007. This work was supported in part by Ministry of Science of RS under Grant 144005A.

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$$-\frac{d^2\omega}{dx^2} = \lambda\omega(x), \quad x \in (0,\xi) \cup (\xi,1)$$
$$\omega(0) = \omega(1) = 0$$
$$[\omega]_{x=\xi} = \omega(\xi+0) - \omega(\xi-0) = 0 \qquad (4)$$
$$-\left[\frac{d\omega}{dx}\right]_{x=\xi} = \lambda K\omega(x)$$

The solution of the spectral problem (4) can be written in the form:

$$\omega(x) = \begin{cases} A\sin\alpha x, & x \in (0,\xi) \\ B\sin\alpha(1-x), & x \in (\xi,1) \end{cases}.$$

It is obvious that $\omega(x)$ satisfies the boundary conditions.

The values of the constants A and B can be obtained by the first condition of conjugation:

$$A = \sin\alpha(1-\xi) \quad \text{and} \quad B = \sin\alpha\xi.$$

The equation $-\frac{d^2\omega}{dx^2} = \lambda\omega(x)$ gives $\lambda = \alpha^2$. Using the second condition of conjugation, one obtains:

$$\alpha = \frac{1}{K}\left[\cot\alpha(1-\xi) + \cot\alpha\xi\right], \quad (5)$$

The right hand side of the equality (5) is the sum of the two periodical functions which, in general, have different periods. So, this equation has a countable set of solutions: $\alpha = \alpha_n$, $n = 1,2,\ldots$, from which one can get eigenvalues: $\lambda = \lambda_n = \alpha_n^2$, $0 < \lambda_1 < \lambda_2 < \ldots < \lambda_n \to \infty$ and corresponding eigenfunctions: $\omega = \omega_n(x)$, $n = 1,2,\ldots$.

In some cases, there exists another family of eigenvalues and corresponding eigenfunctions that is the solution of the spectral problem (4). Solutions such as this one are called "parasite solutions." Functions from this family are:

$$\omega(x) = \sin\alpha x, \quad x \in (0,l)$$

and conditions of conjugation are:

$$\omega(\xi) = 0 \quad \text{and} \quad \left[\frac{d\omega}{dx}\right]_{x=\xi} = 0.$$

The parasite solutions appear if ξ is rational, i.e. $\xi = \frac{p}{q}$ (one can obtain this from the second boundary condition and the conditions of conjugation). In that case $\alpha = nq\pi$, so the eigenvalues and corresponding eigenfunctions are:

$$\lambda_n = (nq\pi)^2, \quad \omega_n(x) = \sin nq\pi x, \quad n = 1,2,\ldots.$$

3. *Graphical Illustration*

If $\xi = \frac{1}{3}$, the equation (5) takes the form:

$$\alpha = \frac{1}{K}\left[ctg\frac{2\alpha}{3} + ctg\frac{\alpha}{3}\right].$$

In this case, the parasite solutions are:

$$\lambda_n = (3n\pi)^2, \quad \omega_n(x) = \sin 3n\pi x, \quad n = 1,2,\ldots.$$

The graphical solution of the equation (5) when $\xi = \frac{1}{3}$ and $K = 1$ is shown in the Fig. 1. The first three eigenfunctions are presented in Fig. 2.

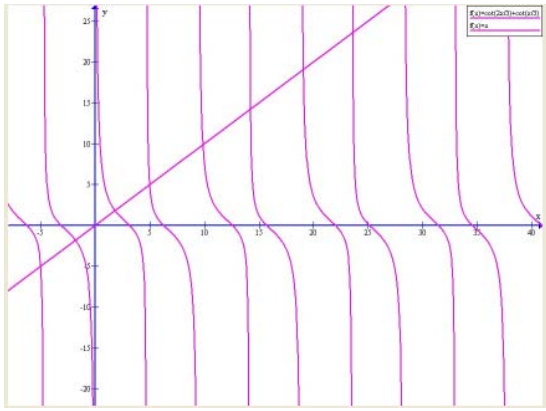

Fig. 1: The equation (5) when $\xi = \frac{1}{3}$

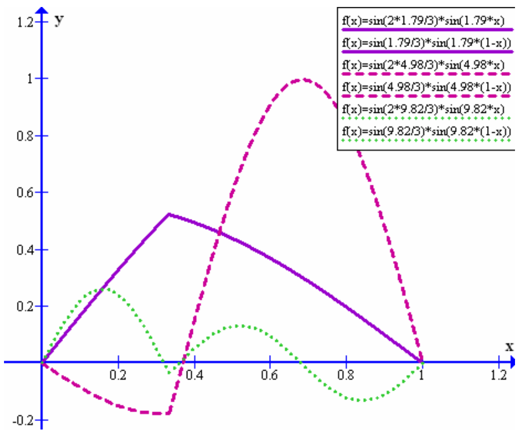

Fig. 2: The first three eigenfunctions when $\xi = \frac{1}{3}$

If $\xi = \frac{1}{\sqrt{2}}$, the equation (5) takes the form: $\alpha = ctg\alpha\left(1-\sqrt{2}\right) + ctg\sqrt{2}\alpha$.

In this case, since ξ is irrational, there are no parasite solutions.

The graphical solution of the equation (5) when $\xi = \frac{1}{\sqrt{2}}$ and $K = 1$, is shown in the Fig. 3. In the Fig. 4 the first three eigenfunctions are presented.

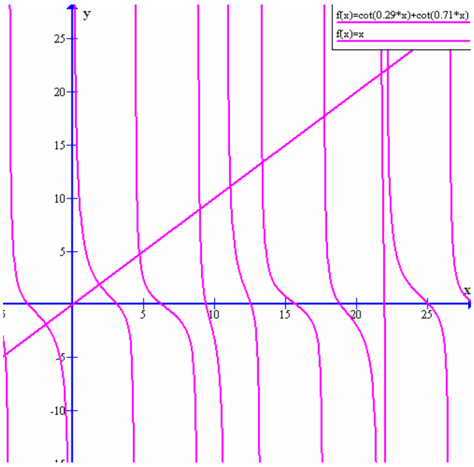

Fig. 3: The equation (5) when $\xi = \frac{1}{\sqrt{2}}$

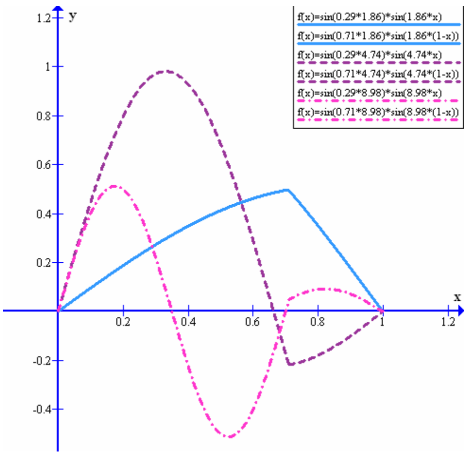

Fig. 4: The first three eigenfunctions when $\xi = \frac{1}{\sqrt{2}}$

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Sustainable Development: Science Must Precede Public Policy

Cotner, M., Douglas

Abstract— ***A suggested approach for the development of sustainable communities will be briefly explored in this paper. It will consider the problem of sustainable development, a brief discussion of methodology, the public policy issue, and a suitable conclusion. The first precept of sustainable development is to "do no harm". The approach herein taken bears this injunction in mind, as it incorporates the cutting-edge technique of Ecological Footprint Analysis accompanied by the underpinning theoretical construct of A Unified Field Theory of Adapted Space, which is a new idea not previously seen in the literature. This research recognizes that there may be drawbacks to the approach offered, such as the absence of national statistical data sets. However, this approach seeks to employ techniques that offer the possibility of insight, and which has the capability to quantify biophysical goods consumption, while equating such consumption with appropriated eco-logical carrying capacity of land equivalents. This approach also offers the potential of developing a practical and scale variable approach to concretizing sustainable development in the lives of ordinary people.***

Index Terms— ***Adapted Space, Carrying Capacity, Biophysical Goods, Ecological Footprint, Photo- voltaic (PV), Sustainable Development.***

1. Introduction

THIS work explores sustainable development from the perspective of first principles. The approach taken incorporates the assessment technique known as Ecological Footprint Analysis, (Rees, W. & Wackernagel, M. 1994) and the underpinning theoretical construct of A Unified Field Theory of Adapted Space, (Cotner, D. M., Doctoral Dissertation, The American Institute of Urban and Regional Affairs, 1998). There will be more about this later in the article. To understand Sustainable Development, it is essential to understand how real people use real space in real time, (Whyte, W. "The Social Life of Small Urban Spaces" 1988). This new theory, attempts to answer basic questions concerning people's use of space and their patterns of resource utilization over time. Thus, population groups or societies are empowered to determine their own ordering of developmental priorities, as they seek to make development sustainable. Consequently, the technique of Ecological Footprinting invites everyone to the table. It says here is the biophysical goods budget that is available, so how do we want to utilize it? Simultaneously, A Unified Field Theory of Adapted Space gives explanation to both the individual and collective behaviors that generate sustainable development activities and the consequent character and morphology of a given human settlement.

This research builds upon the work of Dr. William Rees and Dr. Mathis Wackernagel who were the first to formulate the paradigm of the Ecological Footprint. The next step in configuring a model for sustainable development is to consider an underlying theoretical mechanism that explains why and how people organize their environmental space for the various purposes of everyday living. This underlying construct is known as, A Unified Field Theory of Adapted Space and this is first time that this idea has been articulated in any journal. This theoretical construct is rooted in the concept of Sequent Occupance, as developed by Derwent Whittlesey (1929). Sequent Occupance analyzes the ways in which a culture uses a place or a region in its own way. A Unified Field Theory of Adapted Space builds on this work and that of William H. Whyte (1988) to gain definitive answers concerning how real people use real space in real time for daily human purposes, and by extension, their acquisition and consumption of biophysical goods from the Earth's ecosphere and geosphere.

A Unified Field Theory of Adapted Space considers the elements of population (size, distribution, and dynamics), spatial occupance (contemporary and sequent human use), and individuals who adapt space for daily living requirements. When bound to Ecological Footprint Analysis, there emerges for the first time, a powerful analytical suite that can determine the requirements for sustainable development at local, regional, national, and global scales. Such a construct looks afresh at the ideas of Landscape Ecology, Sequent Occupance, and the spatial behavior of people. This theory recombines these ideas into a unified perspective. Such recombination allows complex problems of sustainable development, the solutions of which can now be attempted with far greater confidence, than has heretofore been possible. Much work remains to be done,

Manuscript received March 11, 2007.
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because as sustainable development has evolved from its early beginnings it has drifted from its original theoretical foundations, risking its reputation for relevance. Thus, a deviation from original focus on the interconnections that link complex ecological, social, and economic systems has emerged.

2. *The Problem*

Human culture and the societies of which it is composed are now in conflict with the planet, because ecological footprints now greatly exceed the ecological productivity contained within the boundaries of nation states, as they are known today. It is now clear that humankind has entered a period of consequences not heretofore experienced. These consequences are the result of the volume and the rate of resource consumption by a world population that is growing very rapidly, which is exerting great pressure on the ecological carrying capacity of the Earth's biosphere. Because these consequences play into sustainable development, a complex problem is presented to policy makers. In this context, they should be afforded every opportunity to understand and to buy into what the science of sustainable development offers to them when decision-making is required on such matters. This of course can be fraught with certain difficulties because of the complexity of the science and the often-encountered resistance to the science on the part of policy makers. For example, Upton Sinclair once said "… It is difficult to get a man to understand something when his salary depends upon his not understanding it…" This is often what happens, but with persistence, this mindset can be changed. Consequently, as policy makers become more comfortable with data developed from ecological footprint analysis, they will regard this type of data as indispensable to their work, as formulators of environmental and developmental policy, thus avoiding the problem as stated by Upton Sinclair. At least, this is the hope.

Are there yet problems with which to contend? Yes, there are some, which are bound up in the availability of both historic and current demographic, economic, and trade data (national data sets). This research recognizes that there may be limitations to the approach as herein offered because of possible data voids. However, the approach taken to the problem, seeks to employ techniques that can quantify and explain biophysical goods consumption, equating such consumption to ecological carrying capacity of ecologically productive land equivalents. This approach is heavily data dependent, as can be seen in the table below. If there are potential limitations to the approach taken, it is in this area and the availability of national data sets that are current or reasonably current, which will mitigate the computational burden. Otherwise, significant primary data gathering through fieldwork must be undertaken. In this regard, much credit must be given to Dr. Mathis Warkernagel and his Global Footprint Network. The data developed by this footprint network holds profoundly negative implications for the furtherance of Globalization, as both a phenomenon and as an instrument of world economic policy. The Global Footprint Network puts the matter into proper perspective, as can be seen in the table below. This table reflects the complexity represented by the interaction between population, ecosystems, and economics, which goes to the heart of Sustainable Development and the creation of livable human communities.

ECOLOGICAL FOOTPRINT AND BIOCAPACITY DATA-2003

Place	Popula-tion (Mil-lions)	Total Ecolog-ical Footprint (global ha/per-son)	Total Bio-Capacity (Global ha/per-son)	Ecologic-al Deficit (-) or Reserve (+) global ha/per-son)
World	6,301.5	2.2	1.8	-0.5
High Income Countries	955.6	6.4	3.3	-3.1
Middle Income Countries	3,011.7	1.9	2.1	0.2
Low Income Countries	2,303.1	0.8	0.7	-0.1
Serbia & Monte-negro	10.5	2.3	0.8	-1.5

(Source: Courtesy of Global Footprint Network 2006: Ecological Footprints and Biocapacity)

3. *Discussion*

The work of Rees and Wackernagel pro-vides the environmental accounting tool, Ecological Footprint Analysis. This technique allows the researcher/analyst to assess the ecological impact of biophysical goods consumption by a study population, while "A Unified Field theory of adapted space" combined with this accounting tool rounds out the suggested construct for sustainable human communities. While ecological footprint analysis provides the quantitative methodology, a unified field theory of adapted space facilitates a new underlying insight into the dynamics of biophysical resource consumption by a given population of human beings. The final part of this construct is the factor of "Public Policy". The formation and promulgation of public policy is most often the realm of elected officials. Moreover, they form this policy with the resources that they have at hand, with which they are familiar. They often engage in policy formation dealing with Sustainable development without benefit of the underpinning Science of Sustainable Development and in some cases ignore it altogether. However, with careful analysis and planning this sometime failing may be avoided. A Unified Field Theory of Adapted Space considers the elements of population (its size and distribution), spatial occupance (both contemporary and sequent human use), the individual's need to adapt space for daily living, and human purposes which are essential for the experience of place. This construct facilitates more fully, our understanding of how people in a particular place modify space to meet their particular needs. When linked to Ecological Footprint Analysis, there is for the first time, a powerful analytical suite for deter-mining the requirements for sustainability generally and sustainable communities specifically. Thus, how a human settlement, regardless its size and its behavior modifies space over time, as well as the pattern and nature of its consumption of biophysical goods (food, fuel, and fiber), such behavior will determine whether or not a place, and its population are sustainable. The tools and ideas that are used to calculate and assess the sustainability of a human settlement are suggested to be Ecological Footprint Analysis and A Unified Field Theory of Adapted Space, as earlier set forth. Further, that the work of this research would be remiss if it did not take up the subject of energy, which is a critical component of what makes a community, city, region, or state sustainable, as well as livable.

Just as there can be no human settlement without water, so it must follow, that without energy, human communities are neither possible nor are they sustainable in the twenty-first century. It also follows, that this energy must be available, affordable, and sustainable. Such energy must also be carbon-free, to the extent that this feasible. As energy supply becomes increasingly problematic for human settlements, the limits of growth will be tested. This growing reality will greatly influence how people adapt space for a variety of human purposes.

As technology evolves, communities may not remain 100% dependent upon a centralized power grid, but rather have available to them, an onsite bundle of renewable and thus sustainable energy sources, and the technologies to utilize such energy sources. These may include Photovoltaic Cells, the Wind, Methane Generators, and Proton Exchange Membrane Fuel Cells. It should be noted in this regard, that Germany has become a leader in renew-able energy technologies. It is the world leader in the manufacture and sale of photovoltaics. For example, Germany's photovoltaic market grew 53% to 837 megawatts in 2005, which corresponds to a 57% world market share. This market level is eight times larger than the market share held by the United States. By comparison, beyond Germany, even Japan's 14% PV growth took it to only 292 megawatts, (Future Pundit: "Rapid Growth In Photovoltaics Demand Driven by Germany," 2006). This article may be found at www.futurepundit.com/archives/003363.html

4. *The Public Policy Issue*

Once policy makers embrace the science of sustainable development, and when ecological foot-printing becomes an integral component of the planning process, these agents of government will find many reasons to brand the programmatic elements of sustainable development as their own. Early program elements such as sustainable tourism should be viewed as a bridge to a more enduring local, regional, and national, sustainability. At this time, however, more extended sustainable development initiatives have yet to emerge. Smaller nations must take special care, as policy-makers act, under the rubric of Sustainable Development. Countries that have recently emerge from a watershed of national upheaval, such as the Republics of Serbia and Montenegro must take special care, because of their unique risk exposure to the pressures of globalization, which has its own set of imperatives and which often conflict with the needs and concerns of smaller nations. First principles should be "do no harm" which strongly suggests caution in the formation of national development policy.

A Brief Account of Sustainable Communities

The United Nation's recent 2006 report for sustainable development in both Serbia and Montenegro is probably the most extensive report on sustainability for this part of the former Yugoslavia that has yet been written. However, the contents of these reports do not represent an answer to the question of facilitating the creation and maintenance of sustainable communities in this part of Europe. The "Assessment of Development" reports for Serbia and Montenegro address only the following areas:

1. Introduction to the work of the report.
2. National Challenges and Strategies.
3. UNDP in Yugoslavia.
4. Assessment of Development Results.
5. Management of UNDP Assistance, and
6. Conclusions, Lessons, & Recommendations.

To make this information useful in the support of a stratagem or strategies for sustainable communities, one must examine human communities both before and since the onset of the industrial revolution and the arrival of the modern nation state in the Balkans. Historically, Montenegro has been a land of kings, tribal allegiances, trade, revolution, resistance, subsistence agriculture, and national aspirations. However, in the opening decade of the twenty-first century, the more formalized issue of the sustainability of communities and the nation have become paramount, in contrast to the social, cultural, political, and economic issues of past centuries. People must now ponder, how does a small and compelling culture navigate a rapidly globalizing world? This is neither an easy or straightforward question to answer. Recently, however, the government of Montenegro let it be known that its stratagem for a sustainable Montenegro will be via Sustainable Tourism. As a matter of policy, sustainable tourism and sustainable communities have now been wed. This can be a fruitful approach, if and only if, it leads to a more broadly based approach to sustainable development. It must be locally based and at the same time aligned with regional and global sustainable development goals, as far as that may prove to be feasible, and which is in the best interests of the people of Montenegro.

The government of Montenegro now believes that sustainable tourism in Central and Northern Montenegro, as initially focused on the Durmitor Region, is the way forward in the confrontation of poverty, unemployment, environmental protection and/or degradation issues, (UN Development Program Report (UNDP) and Ministry of Tourism, "The Economy and Environment for Sustainable Development in Northern and Central Montenegro, 2004, 2005, 2006"). Tourism, sustainable or otherwise, tends not to be a value added activity. It is very much akin to a special form of resource extraction. As such, it can be subject to the vagaries of globalizing economic cycles. Thus, when tourism is good it is very good, when it is not, those dependent upon it are not. Because Montenegro is a relatively small country, tourism, even sustainable tourism, contains within it, the very real seeds of risk that can transform an authentic culture into an ersatz cultural theme park. This must be rigorously guarded against.

5. Conclusion

The issue of sustainable development has become a contemporary public imperative. For much of the former Yugoslavia, the efforts of Montenegro, which have been aimed at sustainable development, may point the way forward for all, provided Sustainable Tourism leads to a more enduring mechanism that will facilitate sustainable communities. However, the there are always unintended consequences that may derive from Sustainable Tourism. What then lies beyond sustainable tourism? The key to what lies beyond may be the factor of Smallness. Smallness in this context refers to a population that has endured, and which occupies a geographically diminutive physical region that is unique. It is population capable of progressively engaging, with minimal bureaucracy, developmental initiatives that will lead to sustainable/livable communities. With a population of approximately 630,548 persons, within an area of 13,938 kilometers, Montenegro meets the definition of smallness. Thus, by being comparatively small, Montenegro possesses the potential to be nimble, resilient, and ingenious, which are first principles of authentic sustainable development, as it was originally envisioned, rather than the bureaucratized exercise of governmental power that it has somehow become today. Therefore, to successfully concretize these qualities, leaders must stress localized development that is doable and which can be easily aligned with wider scale sustainable development initiatives. The temptation to revert to the old Soviet-style approach may be comfortable for some and in like manner, they should not swallow completely, the so-called "Free-Market Model". However, without a national ecological footprint accounting program long-term sustainable development and creation of livable communities will be greatly inhibited, regard-less the direction policy makers may decide to take. In closing, it will be the reader's job to agree or disagree with the contents of this paper, its style and findings, which are perfectly acceptable, so long as a constructive dialogue emerges in the wake of this very brief but hopefully, evocative work.

Acknowledgment

The author would like to acknowledge the following individuals for their help, encouragement, and assistance in the development of this paper:

1. Professor Veljko Milutinovic of the University of Belgrade.
2. The Late Dr. Troyt York who passed away this year and who was for many years the driving force and president of The American Institute of Urban and Regional Affairs.
3. Those professionals, academics, and scholars who took the time to constructively review this paper.

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A New Decision Algorithm for Vendor Selection in Chinese Banks

Zhao, Chen

Abstract— ***As Chinese banking completely opened their global business from the end of 2006, the competition with international banks became more comprehensive. Due to the lack of advanced management experiences and technology support, the long-term strategic cooperative vendors and service providers are more important and critical than before for the developing Chinese banks. Therefore, an appropriate selection of this partnership plays a big role and gets more and more attentions. During past 20 years many decision approaches have been proposed. Two of them, analytic hierarchy process (hereinafter refers to AHP) and data envelopment analysis (hereinafter refers to DEA), have been successfully used in many applications individually. However, the single decision strategy is not enough for new challenges that appeared in Chinese banks recently.***

In this paper, a new decision algorithm combining AHP and DEA is proposed and we use a purchasing problem as an example. Our method is based on Weber and Dickson's normative criteria system, which has not been widely used in Chinese banks before. After comparing advantages and disadvantages of above two methods, a solution is therefore devised from a research project of Industrial and Commercial Bank of China (hereinafter refers to ICBC) (the largest bank in China, also one of the largest ten in the world). The final decision is a trade-off between AHP and DEA, which avoids disadvantages from each of them. The project reported in this paper demonstrates our approach.

Index Terms— ***Chinese Banking; Evaluation Criteria; Weight; Analytic Hierarchy Process; Data Envelopment Analysis***

1. INTRODUCTION

ON the fifth anniversary of the accession to the WTO, Chinese banking completely opened their global business from December 11th, 2006. Accordingly, the competition with international banks became more comprehensive. By the end of last September, the total assets of foreign-funded banks in China exceeded 100 billion U.S. dollars, and 14 foreign-funded or joint-venture banks were registered in China, with 17 subsidiary banks or other affiliated institutions [1]. April 23, 2007, four foreign banks opened RMB business to local residents. Foreign banks business in China has grown by 20% this year. Due to the lack of advanced management experiences and technology support, the long-term strategic cooperative vendors and service providers are more important and critical than before for the developing Chinese banks.

In recent years, most of Chinese banks have set up data centers to accomplish data consolidation. To ensure the speed and security of data transmission, banks spend a huge amount of money in information technology. This annual investment is over 100 million U.S. dollars. However, technical departments in a bank are nonprofit sectors. Therefore, high efficiency of this investment is always desired and the concept of partnerships between buyers and vendors for the technical sectors is receiving increasing attention.

During past two decades, many decision approaches have been proposed. Two of them, AHP and DEA, have been successfully reported in many applications individually. Weight of AHP is given by experts based on the actual situation, but it may be very subjective or even may lead to corruption. Weight of DEA is from pure mathematical calculations, though accurate, often inconsistent with the actual situation. Consequently, each single strategy has limited capability to tackle the new challenges appeared recently in Chinese banks.

Selecting vendors by experts' evaluations are the most popular procedure in Chinese banks. However, as the experts have different evaluation criteria, the final decision is difficult to deliver satisfaction to all levels. After years of purchasing practice and the relevant information analysis, we propose a new decision algorithm that combines AHP and DEA. The final decision is a trade-off between the two methods, which inherits the advantage and avoids the disadvantages of each of them. To demonstrate our approach, we refer to a set of data from a research project of ICBC to apply the method. As a pioneering method of making purchasing decision in a systematic way, it brings a brand new way of vendor selection in Chinese banking sector.

2. EVALUATION CRITERIA OF VENDOR SELECTION

In China, there was not any well-established normative criteria system for vendor selection. Most of the enterprises used to make their

Manuscript received March 6, 2007.

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decision by experience. The first research of this criteria system has begun oversea by Dickson Gary W. since 1966. In Dickson's literature, he mentioned 23 criteria for vendor selection. Moreover, he made a survey of these 23 criteria from 273 members of the American Purchasing Manager Association [2].

In 1991, Weber summed up 74 literatures from 1967 to 1990 that studied those criteria from different point of view, then made his new order of criteria. In his paper, the highest priority was given to price, on-time delivery and quality, which are the same as Dickson's conclusion. The three criteria are in the quite important ranking [3]. And service, product reliability, technique, location are in the important ranking.

But, Weber and Dickson's conclusion are quite different. Dickson represented the purchasing manager's intent but Weber represented researcher's interests. Otherwise, different vocation and different enterprise might have their own criteria for vendor selection.

3. *Research of Vendor Selection Algorithm*

There are mainly three methods of quantitative analysis --- Weight-based Analysis, Mathematical Programming and Probability Statistics. The Weight-based Analysis is most studied and widely applied. Now let's make an introduction of two of the mostly used approaches of Weight-based Analysis.

3.1. Analytic Hierarchy Process (AHP)

AHP was developed by I·L·Saaty in 1970s. It's well suited to group decision-making and offers numerous benefits as a synthesizing mechanism in group-decisions [4]. The prime use of the AHP is the resolution of choice problems in a multi-criteria environment. In that mode, its methodology includes comparisons of objectives and alternatives in a natural, pair-wise manner [5]. The AHP converts individual preferences into ratio scale weights that are combined into linear additive weights for the associated alternatives.

Experts of buyer can perform the task in analyzing the evaluation criteria of vendor selection. AHP is used to structure the evaluation process providing pair-wise comparison mechanisms to quantify subjective factors. A necessary representation of the priorities derived from a positive reciprocal comparison judgment matrix by making a series of pair-wise comparisons among the criteria according to the nine-point scales, and the relative performance measures are computed for vendor's criteria. In the AHP, the scale of absolute values of 1–9[6] (the bigger, the more important) is proposed for the pair-wise comparison scale and definition, which is shown in Table 1.

TABLE1: COMPARISON SCALE AND DEFINITION

Scale	Definition
1	The two elements have the same importance
3	The former element is a little more important than the latter
5	The former element is more important than the latter
7	The former element is highly important than the latter
9	The former element is extremely important than the latter
2, 4, 6, 8	The median of the judgments mentioned above

The AHP is used for analyzing the customer-specific requirements for evaluating the alternative warehouse operators. The AHP-based analysis results in a customer-specific priority for each alternative warehouse operator. This priority describes how well a certain warehouse operator is expected to satisfy a certain customer's performance requirements [7].

From our perspective, the main advantage of the AHP is that it provides a systematic, validated approach for consolidating information about alternatives using multiple criteria [8]. The disadvantage of this approach is that it is too sensitive to bias or the experience of the personnel.

3.2 Data Envelopment Analysis (DEA)

DEA was developed by A·Charnes, W·W·Cooper and E·Rhodes. The DEA is proposed as a multi input/output methodology for evaluation and selection of vendors. It assumes homogeneity among the decision-making units (hereinafter refers to DMU) in terms of the nature of the operations they perform, the measures of their efficiency, and the conditions under which they operate [9]. When the DMU are not homogeneous, the efficiency scores may reflect the underlying differences in environments rather than any inefficiency. One strategy to overcome this is to separate DMU into homogeneous groups. However, one needs large numbers of DMU to do this. Another strategy is to adjust for non-homogeneity. This paper presents three adjustment techniques along with the basic Charnes, Cooper, and Rhodes (hereinafter refers to CCR) model.

The efficiency formula is:

$$E_k = \frac{\sum_{k=1}^{s} u_k y_{kj}}{\sum_{k=1}^{m} v_k x_{kj}} = \frac{u^T y_k}{v^T x_k} \qquad (1)$$

And the CCR DEA model is:

$$\begin{cases} \max \ E_k = \dfrac{u^T y_k}{v^T x_k} \\ s.t. \dfrac{u^T y_k}{v^T x_k} \le 1 \end{cases} \quad (2)$$

Where $x_j = (x_{1j}, x_{2j}, \cdots, x_{mj})^T$ is the input criteria, which is the less the better; $y_j = (y_{1j}, y_{2j}, \cdots, y_{sj})^T$ is the output criteria, which is the bigger the better; $v = (v_1, v_2, ..., v_m)^T$ is the weight of the input criteria, $u = (u_1, u_2, ..., u_s)^T$ is the weight of output criteria. And n is the number of decision make unit, here means vendor's number.

The DEA methodology has the advantage of avoiding the subjectivity of estimating weights to various input and output criteria. However, some studies are carried out to compare the process of selecting vendors using the current practice and this methodology [10]. The results indicate some insignificant differences between them, which means the results calculated by the DEA have some unreasonable factors once in a while.

4. *AHP & DEA Combined Algorithm*

From the analysis above, the two methods both have the advantages and disadvantages. While as weight methods, the most fundamental difference is the choice of weight: AHP uses the decision of experts of buyer as the basis of choosing weight, while DEA calculates the weight based on actual data.

There are many methods similar to AHP, for instance, Delphi and Multi-criteria Decision, etc. These methods are uniformly called Subjective Weight Evaluation (hereinafter refers to SWE) method [11]. To overcome the drawbacks of the subjective decision, some remedies could be carried out such as to bring more experts and be more restricted in choosing experts. This type of methods got the advantage that the experts could sort the weight of criteria according to the application of buyer's requirement. In other words, although SWE cannot assign accurate either the score of vendor or the final selection, however, it can decide the actual importance of the weight of evaluation criteria.

DEA overcomes the disadvantage of the SWE, so it is also called Objective Weight Evaluation (hereinafter refers to OWE) method [11]. In the same category, there are Grey Prediction and Major Element Analysis method, etc. The advantage of such method is completely objective, without any subjective factors, while it brings an inevitable shortcoming. Under some certain conditions, the calculated weight may contradict with the actual practice.

Theoretically, although the AHP is subjected to human factor to evaluate the weight, the order of the weights is reasonable in most cases and the AHP shall be considered as basic means.

Suppose a_i is the weight calculated by AHP, b_i is the weight calculated by DEA , and M_i is the final efficiency of the vendor, thus:

$$\begin{cases} Mi = \dfrac{1}{2}\sqrt{(\alpha ai)^2 + (\beta bi)^2}, \quad i = 1, 2, ..., m \\ \alpha + \beta = 1 \end{cases} \quad (3)$$

Where m is the number of the evaluation criteria. The discussion of coefficient α and β is given below:

If there is no difference among the order of criteria, and the weight ranking calculated by DEA is same as the weight ranking calculated by AHP, we can use DEA's weight as weight of individual indexes, thus:

$$\alpha = 0, \quad \beta = 1 \qquad (3.1)$$

If there is large difference among the order of criteria, and the weight ranking calculated by DEA is quite different from the weight ranking calculated by AHP, hereby, DEA's weight is not referenced in decision making, then we could use AHP's weight as weight of individual indexes, thus

$$\alpha = 1, \quad \beta = 0 \qquad (3.2)$$

If there is a little difference among the order of criteria, and the weight ranking calculated by DEA is not same as the weight ranking calculated by AHP, we could use the average of the weights calculated by two different methods as weight of individual indexes, thus:

$$\alpha \overline{ai} = \beta \overline{bi} \qquad (3.3) \ .$$

5. *Project*

To illustrate the algorithm developed above, we consider applying it to a project as an example in which most of the decision-relevant factors are included.

ICBC is a leading financial player in China with an outstanding customer base and multi-dimension business structure. It boasts core competence in innovation, market competitiveness and premier brand value. ICBC is the largest bank in China by total assets, total employees and total customers. And it is also the largest bank in Asia, also one of the largest ten in the world [12].

In this project, ICBC needed to select a vendor to support UNIX server from three candidate vendors: A, B and C. The relevant data are summarized in Table 2. It shows the comparison judgment of the five criteria: price, company strength (debt-to-asset ratio), quality (system matching), on-time delivery (due date) and performance history (satisfaction survey of service). The third column is the annual maintenance service cost after the warranty expired.

TABLE 2: VENDORS' DATA

Vendor	Price (RMB)	*Costs (RMB/year)*	Strength (%)	Quality (%)	Delivery (days)	Service (%)
A	4,284,000	*31.22*	72.4	100	15	90.6
B	3,950,000	*14.75*	53.0	96.3	7	95.8
C	3,325,000	*N/A **	52.0	92.7	7	81.9

*: Vendor C unable to provide the exact cost.

5.1. Solution of AHP

According to experts' evaluation and the data of these vendors, we list the pair-wise comparison judgment matrix in Table 3.

TABLE3: CRITERIA RECIPROCAL PAIR-WISE COMPARISON JUDGMENT MATRIX

	Price	Strength	Quality	Delivery	Service
Price	1	5	1/3	3	1/2
Strength	1/5	1	1/7	1/3	1/6
Quality	3	7	1	5	2
Delivery	1/3	3	1/5	1	1/4
Service	2	6	1/2	4	1
Sum	98/15	22	457/210	40/3	47/12

It follows that we calculate the weight of each criterion by AHP shown in Table 4, as well as the order of the weights:

TABLE 4: WEIGHT OF CRITERIA CALCULATED BY AHP

	Price	Strength	Quality	Delivery	Service	Weight	Order
Price	15/98	5/22	70/457	9/40	6/47	*0.177*	3
Strength	3/98	1/22	30/457	1/40	2/47	*0.042*	5
Quality	45/98	7/22	210/457	15/40	24/47	*0.425*	1
Delivery	5/98	3/22	42/457	3/40	3/47	*0.084*	4
Service	30/98	6/22	105/457	12/40	12/47	*0.273*	2

Similarly, referring to Table 1, we list all judgment matrices of the vendors for each of criteria:

Price	A	B	C	weight
A	1	1/3	2	0.239
B	3	1	4	0.623
C	1/2	1/4	1	0.137
Sum	4.5	19/12	7	

Strength	A	B	C	weight
A	1	1/3	1/3	0.143
B	3	1	1	0.428
C	3	1	1	0.428
Sum	7	7/3	7/3	

Quality	A	B	C	weight
A	1	4	4	0.655
B	1/4	1	2	0.211
C	1/4	1/2	1	0.133
Sum	1.5	5.5	7	

Delivery	A	B	C	weight
A	1	1/3	1/3	0.143
B	3	1	1	0.428
C	3	1	1	0.428
Sum	7	7/3	7/3	

Service	A	B	C	weight
A	1	1/2	3	0.320
B	2	1	4	0.557
C	1/3	1/4	1	0.123
Sum	10/3	1.75	8	

Finally, we got the results of these three vendors' weight calculated by AHP:

TABLE 5: VENDOR'S WEIGHT CALCULATED BY AHP

	Price	Strength	Quality	Delivery	Service	
	0.177	*0.042*	*0.425*	*0.084*	*0.273*	
A	0.239	0.143	0.655	0.143	0.320	0.426
B	0.623	0.428	0.211	0.428	0.557	0.406
C	0.137	0.428	0.133	0.428	0.123	0.168

Accordingly,

$$\text{ai}=\left(0.426, 0.406, 0.168\right)^{\mathrm{T}}, \quad i=1,2,3.$$

Then, we can see that the score of vendor A and vendor B are very close in the solution, and AHP has suggested that vendor A should be the best choice.

5.2. Solution of DEA

Deriving from the formula (2), we could establish a rigorous connection between DEA's model and the theory of vendor selection which is followed:

$$\begin{cases} \max\ \mu^T y_k \\ s.t.\ \omega^T x_j - \mu^T y_j \geq 0,\ \ j=1,2,...n \\ \omega^T x_k = 1 \\ \omega, \mu \geq 0 \end{cases} \tag{4}$$

According to Table 2, we suppose price, company strength (debt-to-asset ratio), and on-time delivery (due date) are the input criteria, which is the less the better, and suppose quality (system matching) and performance history (satisfaction survey of service) are the output criteria, which is the bigger the better. It followed that:

$$E_A = 0.859,\ E_B = 1,\ E_C = 1.$$

That shows us that vendor B and C are both more reasonable than vendor A.

TABLE 6: WEIGHT OF CRITERIA CALCULATED BY DEA

	Input criteria			Output	
	Price	Strength	Delivery	Quality	Servic e
Weigh t	0.016 4	0.0001	0.0325	0.9116	0.1275
Order	4	5	3	1	2

5.3. AHP and DEA Combined Solution

Compare table 4 with table 6 we can learn the order of criteria calculated by AHP was almost coincident with the order calculated by DEA, there only are two criteria's order was exchanged, on-time delivery and price. According to Dickson and Weber's research, these two criteria are in the same weight ranking, which the highest priority. In conclusion, we use the formula (3)-1 in below:

$$\alpha\overline{ai} = \beta\overline{bi}$$

$$\begin{cases} \text{bi} = \left(0.859, 1, 1\right)^{\mathrm{T}} \\ \overline{ai} = 0.333 \qquad\qquad i=1,2,3 \\ \overline{bi} = 0.953 \end{cases}$$

thus, $\alpha = 0.741$, $\beta = 0.259$

$$M_i = \left(0.193, 0.198, 0.144\right)^{\mathrm{T}}.$$

The numerical result shows that vendor B now has the optimal score. This is different from the conclusion of AHP in which vendor B is close to but not the optimal choice vendor A. On the other hand, DEA implies that vendor A is not a reasonable choice. The combined algorithm draws the conclusion that vendor B is the rational choice. Obviously, from both numerical and theoretical analysis, vendor B is the most appropriate choice for this project.

6. CONCLUSION

Chinese banks in today's global competitive markets struggle to gain competitive predominance in all aspects of their operations. Vendor selection is the essential part of them. The algorithm proposed in this paper combines two most popular algorithms of vendor selection, which not only inherits the advantage of judging by experience from the AHP method while avoiding the negative effect due to over-subjectivity, but also incorporates the advantage of object analysis of the DEA method while overcoming its shortage in practical applications. The project demonstrated our approach.

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On the Equivalence of Matter to Energy and to Spirit

Gorga, Carmine

Abstract— ***A basic assumption in logic is that the principle of equivalence formulates a relation among three terms. Yet, there is no recognized third term in physics that completes the established relation of equivalence between matter and energy. This paper suggests that the third term to which both matter and energy are equivalent can be posited to be spirit. Spirit is defined both as the link—as glue—that holds matter and energy together and as Spirit, a notion that is akin to the spirit of God, which is by definition everywhere. All three terms might eventually be measured by a calorimeter. If this application of the principle of equivalence is accepted, physics is transformed from a linear into a relational discipline. And then everything will change in the "two cultures", namely in both the physical and the social sciences.***

Index Terms— ***Equivalence, equivalence of matter to energy, equivalence of matter to energy and to spirit, linear rationalism, relationalism***

1. Introduction

EINSTEIN established a relation of equivalence between matter and energy [1]. An equivalence relation is composed of three distinct and separate terms. To the knowledge of this writer, so far there is no identified third term to which both matter and energy are equivalent. Hence the relationship is not formally valid yet. This paper proposes that the third term of the equivalence be posited to be spirit.

After observing some of the canonical requirements of the equivalence relation and the fundamental advantages of casting our thought processes into this format for the force it brings to our reasoning, we shall first note the shortcomings of some potential solutions to the lack of formal validity of the equivalence of matter to energy and then we shall try to obtain an operational definition for the word spirit. Only then shall we observe some of the consequences of accepting the proposal of making spirit the third term of the equivalence.

If the proposal stands to all the tests of validity, this solution will eventually yield two considerable benefits. It will transform physics from a linear into a relational discipline. It will also tend toward the reunification of the physical with the social sciences.

Manuscript received February 27, 2007.

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2. Problem Statement

Matter and energy are two terms. $E = mc^2$ is not an equivalence relation; c^2 is not a third term: c^2 is a unit of measure (of speed). As logicians know, to be valid, an equivalence relation must be composed of three terms. The three terms have to be reflexive (namely identical to themselves throughout the discourse), symmetric (one observes the same entity from two points of view in order to obtain a deeper understanding of both entities), and transitive (a third term must exist to which both terms are equivalent in order to eschew the confines of circular reasoning and to complete the analysis). With the assistance of the equivalence relation the analysis does not start from an arbitrary point nor does it end at an arbitrary point, but is rigorously interlocked.

These observations can be made more evident by specifying the progress of our thought processes and by casting them into a set of figures. Science eschews all singularities. There is a good reason for this practice. A single point, a single observation does not lead to an objective, replicable analysis or experiment. Analysis begins with the observation of two events. Yet, the observation of two events necessarily leads to circularity of reasoning.

Once we are faced with only two observations, we are obliged to observe all possibilities. Hence the mind is led back to the exploration of all potential outcomes of the position of Point B on the circumference of the circle in relation to Point A at the center of the circle. This is a process that eventually leads to a reversal of one's position and then to a return to the original position—and no certainty is necessarily acquired in the process. Therefore, science asks for a third term. The third term points the research in the right direction. However, if the third term is placed in a linear position, the end result might be a dispersal of the thought process into the empty infinity of an enlarged circle. Linearity leads to progressio ad infinitum.

It is the equivalence relation that restrains the analysis from collapsing into infinity by constraining the terms into an interlocked relationship as in its standard configuration: A ↔ B ↔ C. The equivalence relation starts in logic and has the widest possible range of applications. All forms of syllogism are based on the equivalence relation. Hence the relation of equivalence is well known to the literati. The equivalence relation is also part and parcel of all mathematics textbooks. It stands at the very foundation of mathematics, in which three fingers of my hand (3 of base 10 number system) are equivalent to the word/number/symbol (three, 3, or III) and to the three apples in front of my eyes. A triangle is based on the equivalence relation. The whole of trigonometry is based on the equivalence relation. Indeed, as R. G. D. Allen pointed out, the rules of equivalence “hold” also for the relation of “equality (=)” [2].

In brief, there are many reasons why it is essential to cast any scientific analysis in the format proposed by the rules of logic in general, and the principle of equivalence in particular. A few of them, not necessarily in their order of importance, are as follows. Logic, as a whole, provides objective criteria for the evaluation of any proposition; most disagreement, as is well known, disappears as soon as the magic words are pronounced: “But that is not logically tenable.” Logic provides guidance to our analysis; without it, we are rudderless. Guided by rules of logic, we know whether or not we have completed our analysis. Logic makes it possible to replicate the reasoning or the experiment.

From the above it inexorably follows that the fundamental relationship that Einstein established between matter and energy is yet incomplete. Two terms do not make an equivalence relation. The relationship between matter and energy is completed only when a third element is found to which both matter and energy are equivalent.

3. Inadequacy of Some Possible Solutions

There are no explicit formulations of a third term to which both matter and energy are equivalent. As pointed out above, c^2 is not a third term, but a unit of measurement of speed that has nearly nothing to do with light. It happens to be the speed of light; hence, at best, it is an attribute of light. By extension, it might be assumed that mc^2 contains in it, not just the meaning of matter, but also—implicitly—the meaning of light. Even if c^2 stood for light, it cannot be the third term because light is a form of energy (clearly in the wave conception of light; or a form of matter in the particle conception of light). Thus, whether light is an intrinsic component of E or m, it cannot at the same time be an extrinsic term to which either E or mc^2 might be equivalent. It cannot appear as an addition to either side of the equation, without creating double counting and without violating the first requirement that each term of the equivalence must be reflexive, namely identical to itself throughout the observation. The addition of the term light does not make the construction symmetric; one cannot change the term light with the term energy (or matter) and obtain positive results: one does not gain a better understanding of either matter or energy. Neither does that addition make the terms of the construction transitive: from light one necessarily goes back to either matter or energy—not to both. These considerations can also be put in common language: a part cannot be confused with the whole. If light is part of energy or part of matter, light cannot be equivalent either to energy or to matter, because this definition would run into the impossibility of equating a part with the whole. Since matter and energy, to be equivalent to each other, must be whole units, namely units or entities all complete in themselves, the third term must also be a whole unit, a whole entity. It cannot be a part of a whole.

The same considerations apply if the term third is assumed to be derived from the equation E = hv, where E is energy, h is Planck's constant (which is equal 1 and thus disappears from the equations of physics), and v is the measure of the frequency of energy radiation emitted as photons, rather than the speed of light.

A more abstract set of considerations are necessary to dispel the notion that space (like the old ether and the futuristic “higher order”) might be the third element of the equivalence. The third element has to have an existence of its own. Take away matter and/or energy and space disappears from our field of observation. Hence it cannot be the third element that would make the equivalence of matter to energy a valid relationship.

We must search for a third term to which both matter and energy are equivalent.

4. Findings

This paper proposes that the search for the third term to complete the equivalence of matter to energy is exhausted with the introduction of spirit into the relationship. This is the answer that Fritjof Capra [3] inspired. One then obtains the following equivalence: matter ↔ spirit ↔ energy. This is a relationship that reads: matter is equivalent to spirit and spirit is equivalent to energy. This is a complete relationship of equivalence, which can be defined as the Relational Reality, and it can be diagrammed using these established protocols:

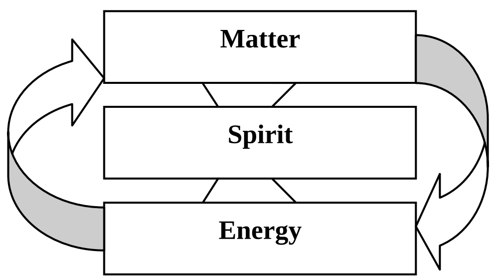

Figure 1: The Relational Reality

Figure 1 can be interpreted not only to mean that matter transforms itself into energy and energy into matter, but—at the very least—especially along these lines: The physical world in which we live has to be observed first from the point of view of matter and then from the point of view of energy. The essential prerequisite is to see these two aspects of reality not in linear fashion, but in a relational mode, namely as two separate and distinct viewpoints of the same reality. When that is done, one can also see that the total reality in which our daily existence is immersed can be grasped only if it is observed, not only from the viewpoint of matter and energy, but also from the viewpoint of spirit. One enters into the stone with a hammer; into the energy of the stone with a cyclotron; and into its spirit with prayer.

Thus we come back to the very roots of our civilization. Our ancestral ancestors—not unlike many brothers and sisters in many civilizations of today—started their analysis of the world neither from matter nor, certainly, from energy. It is fairly certain that they started their analysis of the world form the point of view of spirit.

But what is spirit? Can we obtain a precise definition of this term? Can we obtain an operational definition of this term?

5. *On the Definition of Spirit*

Spirit is incommensurable. Therefore, it is difficult to define. Once it is realized, as we shall more clearly see below, that mathematics, the most precise of all sciences proceeds on the basis of two incommensurable entities, namely zero and infinity, this inherent difficulty that is presented by the word spirit ought not to be of much concern to a physicist. That said, we shall try to identify some of the characteristics of spirit. As used in this paper, spirit is a relation, the relation that binds matter to energy. It keeps them both factually together and intellectually separate from each other. With the word spirit, we can stop thinking of the universe as a linear relationship in which matter somehow passes into energy, and we can start conceiving of the universe of matter being in organic relationship with the world of energy. We can study the objective reality first as a world of matter and then as a world of energy. These are all enclosed worlds of their own. If we conceive of both matter and energy as two entities, indeed as two worlds, in their own, without their individual link to spirit, they would both be in fatal conflict with each other. Instead, we notice near perfect and continuous harmony between the two entities. This we might say is an attempted definition of spirit in the small, as in "the spirit of this stone": spirit is the link, the glue that holds matter and energy together.

By trying to define spirit in the large, as an infinite entity into which both matter and energy are encompassed, and indeed as an infinite entity in which we—observers—are all encompassed, we might gain a greater control over the forces of this world by regaining the sense of what used to be called the "sacred". Only if the earth is seen as sacred again will we feel obliged to respect its inner existence. It is through the word spirit that we reach a better understanding of both matter and energy. Through that word, we enter deeply into their essence and we get in close contact with each of them. In an age in which we are discovering the essential importance of a sound ecological management of the planets, the word spirit will incite us to gain a greater respect for the world of matter as well as the world of energy than we have at present.

Thus the word spirit has a theoretical as well as an operational validity. And then it can inexorably be observed that the infinity of spirit manifests itself to us most clearly as both matter and energy. Hence, the preeminence of the study of physics in today's culture is no longer surprising.

6. *An Extension of the Word Spirit*

But spirit does not manifest itself only as matter and energy. It also manifests itself, indeed, as spirit. Man's mind has forever been engaged in the attempt to define "spirit". We must admit that the task has eluded us. And there is a very good reason why the task is destined to elude us forever. Spirit is not an intellectual affair, hence it can never be caught by the intellect. Since it is an intensely personal relation, indeed an intensely personal affair, the essence of the word spirit can only be caught by our feelings. This is the fundamental reason why approximation to the understanding and explanation of spirit have been in the past the prerogative of mystics, theologians, philosophers, literati, and musicians. As the practitioners of these disciplines have forever made an attempt to convey their understanding of spirit to all other people who may be interested in the topic, so physicists in the future—as they have indeed done in the past (see, e.g., Aristotle and Thomas Aquinas)—have to try to convey to the practitioners of the spirit the goodness, the truth, and the beauty that they discover in both matter and energy.

7. *Some Limitations of the Meaning of Spirit*

One could define spirit as Spirit, namely as God. However, this definition might be misleading; it might lead into the old pitfalls of pantheism. To avoid such dangers, it is necessary to distinguish God from God's spirit; it might be necessary to say that God is also spirit; and then one must be careful to limit God's presence in matter and energy by saying that the spirit of God is also in matter and energy, also in the stone and its energy. If God is by definition everywhere, then—given the above qualifications—it is possible to say that God is also in the stone and in its energy. And then one surprising result ensues: a very practical consequence indeed. It appears that all three entities of thought, namely matter, energy, and spirit might share the same unit of measure: degrees of heat. One of God's characteristics is to be in essence love, Love par excellence. And is not warmth and heat one of the most endearing physical manifestations of love?

8. *Some Implications for Physics*

Not being a physicist, this writer can suggest some of the implications for physics of establishing a true equivalence between matter, energy, and spirit only at a very broad level of generality. When one multiplies the mass by the square of the speed of light, when one spins matter at the squared speed of light, one no longer observes matter but energy. One is no longer in the world of matter, but in the world of energy. One has made such a definite break between the two worlds that, in order to achieve clarity of mind and expression, one must accordingly design a new nomenclature. Using words from one world and applying them to the other leads to analogical thought, but not to innovative and incisive thought.

The second consequence that this writer can envisage is the need to jettison the old attachment to absolute quantification. Quantification in physics has always taken place within sharply defined limits. One has simply to resign to the nature of things that this is the only type of quantification that might forever be viable in physics. In order to reduce the level of apprehension about this condition, physicists will want to notice that mathematics too has always been subjected to this condition. If one does not see the number system as a linear but a relational organization of numbers, it becomes clear that mathematics is based on the following foundational equivalence: $0 \leftrightarrow 1 \leftrightarrow \infty$. The first impression is that mathematics has been able always to proceed with the quantification of only one of its terms: namely, the number 1. Mathematics does not, and cannot quantify either zero or infinity. And it does not matter. Indeed, on second thought, mathematics does not quantify the third of its foundational terms either; mathematics does not present us with an absolute quantification of one, but a relative quantification of one. Numbers proceed from (plus or minus) one to infinity, but they never touch infinity; the conception of the limit is there to recognize this deficiency and to allow us to work within the limits offered by reality. Thus, taking a leaf from the transition from Galileo and Newton to Einstein through Hume in relation to space and time [4], we shall not be concerned with absolute but with relative quantification.

Hence, we can safely maintain that

If the universe is infinite, we shall never weigh its mass;

If the universe is infinite, we shall never measure its length;

What we measure is its mass and its length in relation to man.

Then, man—indeed, every man and woman—is again positioned at the center of the universe.

9. *Some Conceptual Consequences*

In 1946 Einstein remarked: "The unleashed power of the atom has changed everything save our modes of thinking" [5]. With the establishment of the equivalence of matter to spirit and to energy, everything changes. Technically, Figure 1 establishes that while any element of reality occupies its own distinctive position, everything is in full relationship with everything else. Hence, as proved by the Internet, everything is indeed directly related to everything else. This complexity is better observed by rotating at ever increasing speed, not only the entire Figure 1, but also each rectangle inside Figure 1 about its geometric center. One then obtains the image of four circles: one, the circle of matter; two, the circle of spirit; three, the circle of energy; four, the circle of the relational reality as a whole. This is a Venn diagram delimited by a circle. And what is a circle, if not a two-dimensional image of a sphere? Ultimately, one is thus presented with a construction composed of four interpenetrating concentric spheres, one for each point of view from which reality can be observed: the point of view of matter, spirit, energy, and the system as a whole. An analysis of this type of construction can be followed in detail in the humbler reality of the world of economic justice [6] and the world of economics [7]. The mathematics of this construction is well-known [8] and it might be useful to reproduce it here in a very abstract form as follows:

$$\dot{a} = fa(a,b,c)$$
$$\dot{b} = fb(a,b,c)$$
$$\dot{c} = fc(a,b,c),$$

where $\dot{a}$ = rate of change in the first element of the relationship, $\dot{b}$ = rate of change in the second element of the relationship, and $\dot{c}$ = rate of change in the third element of the relationship.

From the linear world of rationalism, thus everything is transformed into the organic world of relationalism. Above all, beyond changes of perspective in physics, if this construction of reality is accepted, the warlike relation between the "two cultures" is expected to change and eventually to come to a screeching halt; with time, this war—with its multifarious manifestations of reductionism, materialism, and atheism, and, above all, mutual misunderstandings—will unavoidably come to a screeching halt.

While waiting for a response to these observations from the people of science, we already know the response from the people of spirit. Poetry and philosophy have spoken forcefully about the evident relationship between matters of the earth and matters of the spirit [9]. Since this writer is more familiar with the Catholic tradition, he will limit himself to one quotation from within this belief system. But many other expressions come easily to mind. "Every culture," Christopher Dawson wrote, "is like a plant. It must have its roots in the earth, and for sunlight it needs to be open to the spiritual. At the present moment we are busy cutting its roots and shutting out all light from above" [10].

If mathematicians and physicists, following strict rules of logic that they already obey in all steps of their reasoning, can be convinced that their own fields—as moral theologians insist—are all immersed into the world of spirit, all other scientists, especially social scientists, will not take long to follow suit. After all, it was Einstein who said: "Science without religion is lame, religion without science is blind" [11].

10. Conclusion

There are many indications that the world of linear, rational, Cartesian logic has come to an end—see, e.g., John Lukacs, At the End of an Age [12]. This is a world in which reality is reduced to isolated atoms. The principle of equivalence is a ready-made tool that allows us to escape the strictures of Cartesian logic and leads us into the world of relational logic, a world in which everything is naturally related to everything else. This paper has used this principle and reached some novel conclusions in relation to physics and mathematics. In the process, it has laid the groundwork for healing the ongoing schism between the "two cultures".

A Postscript

The reader might be interested to know that this paper was not written with the Shroud of Turin in mind. Yet, at one point it became apparent to this writer that the paper makes the Shroud a logical and "natural" necessity. Even the Transfiguration and the appearance of Jesus in the Cenacle become understandable, because—if this reasoning is right—Jesus is, was, and will forever be the perfect union of matter and energy and spirit. And, of course, accepting this reasoning one can see that the consecrated communion host is real.

If this reasoning is accepted to be theologically and logically valid, it leads to a further observation. The study of singularities is not concluded by the study of matter alone, or energy alone, or spirit alone. It is the integration of the three worlds that might yield a better understanding of singularities as well as a better understanding of the world as a whole.

The study of singularities cannot be eschewed by science. Science cannot thus limit itself. Indeed, as various technical studies of the Shroud of Turin prove, science has an essential role to play in the analysis and the distinction of true from false singularities.

Acknowledgment

The author wishes to acknowledge the technical assistance received from his long-standing collaborator, Louis J. Ronsivalli, an MIT food science technologist, and a most positive feedback from Dr. F. Hadi Madjid, a Harvard physicist. The paper has greatly benefited from comments and recommendations from six referees on an earlier draft. Thanks also go to Jonathan F. Gorga for invaluable editorial assistance.

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The publication of this journal
is supported in part by
the Ministry of Science of Serbia

CIP – Katalogizacija u publikaciji
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ISSN 1820 – 4511 =
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