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ECONOMIC DEVELOPMENT OUTSIDE THE STOVEPIPE –THE SCIENCE CONNECTION

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1.0 Setting the Stage

There is a growing consensus that defining user requirements has to be focused on the decision maker. I define "decision maker" broadly to include government, private sector and citizen. The ultimate objective is to propose "what if" scenarios in the context of a series of scientific, political, social, and economic "boundary conditions", and then to allow the decision makers to define the acceptable limits of uncertainty they are willing to accept and still achieve their goals. The result is a set of user requirements.

The process of setting user requirements is seriously flawed from the outset when "science" does not have a seat at the table when those requirements are being set. It is not sufficient to have workshops, focus groups, task forces, stakeholder sessions or seminars where scientific material is presented if the requirement decisions are made in a separate room. Just as important, that seat at the table has to be filled by "science" when the decisions are made on economic development.

Stovepipe development where science is ignored is not possible any longer when science is at the root of so many of the key issues. Yet economic development and planning commissions normally have few if any science literate members. On the other side, science still is too often taught through stovepipe curricula. That stovepipe becomes even more constricted in graduate school.

As science professionals for some time we have recognized that we have great difficulty in speaking the language of decision makers. Errors in translation are reflected back into how user requirements are defined and how user needs are met. It is difficult to think of systems holistically in terms of societal impacts when our training and life experiences basically are specialized.

The philosophy of "specialized" science and the relationship to decision making is changing, and changing quickly. Dr. C. J. Brodrick of James Madison University (private correspondence) gave me a list of some 20 recent papers addressing the issues of science and its role in the decision processes. The National Oceanic and Atmospheric Administration (NOAA), as just one example, has initiated a Social Science Initiative. The initiative seeks to provide a more socially oriented context to the science efforts of the agency. A basic concept is that the requirements and outcomes have to be integrated into the fabric of society so that there are real benefits that support economic vitality and public health. Other federal agencies, such as NASA and USGS, either have aligned their missions around societal impacts or are doing so.

Regional approaches to issues have taken root and emphasize societal impacts. In Virginia, my home state, the emphasis is on regional consortia as the means to solve water and air issues. Across the US, there are more than 450 regional councils or associations of governments dealing with such crosscutting issues as environmental impacts of development, health and transportation. The National Association of Regional Councils (NARC) provides guidance and support to these associations. Regional consortia are more likely to bring science into the decision process than individual local governments.

Educational institutions have joined the "fray". MIT offers a graduate level course in its Urban Studies and Planning program titled: "Use of Joint Fact Finding in Science Intensive Policy Disputes". (http://ocw.mit.edu/OcwWeb/Urban-Studies-and-Planning/11-941Fall2003/CourseHome/) Part of the course description states: "Increasingly scientists and science organizations are confronting a conundrum: Why is science often ignored in important societal decisions even as the call for decisions based on sound science escalates? One reason is that decision-making is often driven by a variety of nonscientific, adversarial, and stakeholder dynamics." I suggest that an equally important reason is that "science" and the scientific process are not well understood by the decision makers. The science planner, if one is even available, does not normally have a seat at the table when the decisions are made. The translation of scientific language into "layman's

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terms" too often is a failure. Science does not surface in the decision process.

My purpose is not to suggest answers to the conundrum posed by MIT. Rather, it is to set down a proposed roadmap for professional societies like the AMS to deal with the conundrum.

2.0 Economic Planners Abound – Where are the Science Planners?

Each of the national and state programs relating to the environment is implemented at the local level. The success of clean air and clean water programs depend on what happens in the cities, villages, counties, or at regional levels. At the federal or state level one can set goals and metrics for measuring success. But, if county comprehensive plans, for example, do not set aside areas to protect watersheds and water sources, or do not properly plan development zones and roads to include environmental standards, federal clean water or clean air metrics are meaningless. Without a local defibrillator, federal and state environmental programs are destined for early cardiac arrest.

Economic planning is considered to be an essential function of every local government. Those local government officials would feel deprived without at least an economic planner on staff, if not a fully staffed office. Funding for economic development commissions is a high priority for any locality seeking to grow. Yet, economic development in the absence of science to back up decisions is stovepipe development.

One of the themes of this AMS meeting is "Living With a Limited Water Supply". It could just as easily have been "Living With a Limited Clean Water and Air Supply". Clean air and clean water are fundamental to economic development. The two are inexorably linked, and are inexorably impacted by development. For example, the Air Resources Laboratory of NOAA estimates that upwards of 78% of the NOx and 47% of the ammonia and ammonium compounds found in the Chesapeake Bay are due to deposition from the air onto into the surrounding watersheds. In a very real sense, clean water and clean air are flip sides of the same environmental coin.

Determining the impact of clean air and clean water on economic development is a fundamental science question. How one deals with that impact are fundamentally sociological and engineering questions. Unless the underlying science is understood, however, along with its relationships to the "nonscientific, adversarial, and stakeholder dynamics" (using the MIT phraseology) the nature and extent of the problem cannot be understood. Lacking that understanding, the societal and engineering responses most likely will be flawed and long-term user needs will not be met. One only has to look to the management of the Florida Everglades as a prime example of building solutions before the science is understood or even undertaken.

As science professionals, we know that science cannot provide a unique answer. For our part, we tend to back away from definitive statements. One reason the National Weather Service now presents much of the forecast information in terms of probabilities and ensemble output is that more and more decision makers use tools that allow (if not demand) a range of input. But, ranges of scientific input can have a totally negative impact when they provide diametrically opposite results. The International Association for Great Lakes Research issued a report (Linking Science and Policy for Urban Nonpoint Source Pollution in the Great Lakes Basin, December 2002) that typifies the dilemma that decision makers can face.

"For example, science cannot offer clear direction regarding future policy regarding phosphorus inputs into the lakes. Some studies suggest that these inputs remain a problem, while others argue that nutrient levels in the Great Lakes are now too low."

Some decision makers demand a black and white answer from science because, if the answer is wrong, the science can be faulted. If that black and white answer is not forthcoming, the science is ignored completely.

Except for "well-heeled" political jurisdictions, science planners in the roughly 5,000 counties across the US are as scarce as hen's teeth. In part that scarcity is due to a lack of education and training. The cross training in science, engineering, politics, societal impacts and the other fields needed for good science planning is lacking in all but a few institutions. Most planners learn science as part of their on-the-job training. Given a need for science-literate people to be involved directly in planning, how does one define a science planner?

3.0 What is a Science Planner?

If I were to write a job description for a science planner it might read something like:

> "Broad base in the environmental sciences is essential, but with no specific specialty, A minor in at least four of the following: social sciences, systems design and analysis, engineering, public relations, political history, economics,

advertising, English literature, environmental law, public health, legislative processes and government, and program planning, A good grasp of what drives local politics is essential. Excellent communications skills required in speaking, writing, and communicating science to the layperson. Experience may be substituted for up to 2 years of study. Salary range: poor to fair."

Very few colleges and universities prepare people to take on the role of "science planner". There is a very strong tendency to "stovepipe" education. Every scientific field has such a large curriculum of fundamentals to be mastered that students have little opportunity to branch out. Higher degrees almost always emphasize specialization. Hence, the stovepipe effect is magnified. Unless the student is "captured" at the undergraduate level, there is little hope that he or she will be able to branch out. Where will the science literate people be educated who are needed to actually implement the cross-cutting programs initiated by federal and state agencies, and non-governmental groups such as NARC?

4.0 Holistic Approach – the JMU Model

James Madison University at Harrisonburg, Virginia, offers a relatively unique program at the undergraduate level. "The Program in Integrated Science and Technology (ISAT) provides a curriculum that integrates the study of science, mathematics, technology, society, and business to develop a graduate with unique professional qualifications. Program graduates are able to play a central role in solving scientific and technological problems in a real-world context (with an appreciation of economic, social, political, and legal constraints), and the ability to communicate and work productively with individuals from a variety of disciplines." (From the ISAT web site at <http://www.isat.jmu.edu>).

Kander (2003) gives a detailed review of the ISAT program. He emphasizes the point that the ISAT graduate is broadly educated in science and technology, but is not an engineer. There is, however, a strong engineering "flavor" to the ISAT program. In 2003, ISAT graduated over 200 seniors. The program started in 1993 with 62 students in its first class. The ISAT faculty consists of 40 persons with doctorates in 30 different professions. Computer science and engineering are well represented on the faculty as is law, environmental science, biological science, education, geography, and philosophy.

Degrees at the Master of Science level are now being offered by ISAT. The program, however, is basically for undergraduates. It is an education program that trains people to take a holistic approach to problem solving. Because the education begins at the freshman level, the holistic approach is ingrained rather than being something applied at the graduate level. That, in my opinion, provides the kind of education needed by the "science planner".

5.0 Two-fold Challenge and Road Map

When one goes to the AMS web site and follows the links to education, you will find the phrase as a sub-title: "Promoting Scientific Literacy in the Nation's Schools". Both pre-college and undergraduate initiatives are available. Both initiatives are stovepipes. They promote meteorological literacy, not scientific literacy. That is not to say there has been no discussion within the AMS of the need for multi-disciplinary education, because there has been. Those ideas have yet to make the front burner apparently as they do not show up in the educational initiatives promoted by the society.

I suggest a two-fold challenge to the AMS and other professional societies. One is to promote the concept of a "science literate planner" and the education of that person. The second is to develop a support system for those who find themselves in that position.

Road maps are the rage in the political arena these days. I propose the following road map for putting a science planner where ever economic planning decisions are made and user requirements defined:

1. There needs to be a "science planner" wherever there is an economic planner. The scientific professional societies need to establish that principle as a policy statement.
2. There needs to be an effort to encourage the establishment of the kind of program that exists at JMU to educate the "science planner". That program should be at the undergraduate level so the person is grounded in multi-disciplinary science, engineering, and social impacts from the outset. A graduate level course or two is not sufficient.
3. An infrastructure of support needs to be developed once that person is in place. At the lowest level that infrastructure might consist of a web page for one-stop shopping relating to environmental issues,

and where one can find assistance. That is no mean task in itself. A step higher would be to develop on-line training to provide a foundation in science literacy for those who find themselves in the position of "science advocate", but lack the training. It may be that the community colleges could be enlisted in this effort. A step higher would be to establish initiatives within the local chapters to encourage local governments to hire "science planners".

The Road Map is not exhaustive. It is only meant to establish broad objectives. Some organization needs to take the initiative to start the implementation of the roadmap.

6.0 Summary

There is a growing consensus that defining user requirements has to be focused on the decision maker. "Decision maker" is a broadly defined term designating government, private sector and citizen. The ultimate objective is to define "what if" scenarios in the context of a series of scientific, political, social, and economic "boundary conditions", and then to allow the decision makers to define the acceptable limits of uncertainty they are willing to accept and still achieve their goals. The result is a set of user requirements.

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A MIT course description posed this conundrum: "Why is science often ignored in important societal decisions even as the call for decisions based on sound science escalates?" As a scientific organization, the AMS has a vital role in addressing the solution to that conundrum.

I suggest a two-fold challenge to the AMS and other professional societies. One is to promote the concept of a "science literate planner" and the education of that person. The second is to develop a support system for those who find themselves in the seat of a science planner. Until "science" has a seat at the table when user requirements are being defined and when economic planning is being conducted, the conundrum will not be solved and economic development will continue to be done in a stovepipe.

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Reference:

Kander, R. G., 2003: A Successful Experiment in Curriculum Integration: Integrated Science and Technology at James Madison University. Proceedings of the 33rd ASEE/IEEE Frontiers in Education Conference, November 5-8, 2003, Boulder, Colorado.