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New Frontiers for Project Management: Earth Science, Monitoring the Planet & Climate Control

By: David L. Pells

Professional project management (PM) continues to grow rapidly in usage and demand worldwide, in most organizations and across all industries. This is especially true in high technology organizations, but in many other industries as well. The world is also rapidly changing, due to the global economy, climate change and other factors. What do these changes mean to project-based organizations and PM professionals? Many of these changes will offer new challenges and opportunities for individuals and organizations involved with project management.

I believe there will be some significant new industries, and major changes in existing industries, that will offer “new frontiers” for projects and PM around the world in the next 10-20 years. Some of these new areas of PM application have been emerging slowly over the last decade, but are now expanding rapidly due to other forces and converging influences. Other new frontiers are in traditional industries and sectors, but based on new global information, perspectives and awareness that are leading to new and massive investments in infrastructure. And some frontiers are growing apparent based on changing demographics and more inter-connected, urban and global human populations and civil society.

In my March 2008 PM World Today editorial, I described Nanotechnology as a New Frontier for Project Management, describing the many fields of science and industry that Nanotechnology is already affecting. In my May editorial, I discussed Future Energy sources and projects as another New Frontier for project management, a trend that is now accelerating as oil & gas prices continue to increase as supplies are stretched and demand continues to grow. As populations and economies grow, the demand for new sources of energy will result in many new projects and an increasing demand for professional project management.

Another “new frontier” for projects and PM is also being affected by recent planetary changes and trends. Over the last decade, climate change, global warming, severe weather and natural disasters have focused global attention on the need to better understand the Earth, mankind’s impact on the planet, and future options for improving both forecasting technologies as well as outcomes. Many scientific projects and programs have been launched in the last few years to study climate change, changes in the polar ice caps, changes in the ocean and ocean currents, weather patters, the ozone, and other topics. At the same time, earthquakes, hurricanes, floods, tornadoes, tsunamis, fires and other several weather causing huge natural disasters have focused attention on climatology, meteorology, oceanography, seismology and other “earth sciences”.

This month, I want to suggest another new frontier for PM, a broad topic that might be grouped together as earth sciences, monitoring of the planet, and climate/weather management. Climate control is the stuff of science fiction, or is it? I think it is still many decades away. But over the next few decades, mankind must invest in a better understanding of the planet, and better tools and methods for predicting and preparing for extreme weather. Let us examine a few areas where this is already occurring, and some implications for the project management profession.

Earth Sciences – Learning more about the Earth

Earth is a complex, dynamic system that mankind does not yet fully understand. The Earth system is comprised of diverse components that interact in complex ways. We need to understand the Earth's atmosphere, lithosphere, hydrosphere, cryosphere, and biosphere as a single connected system. Our planet is changing on all spatial and temporal scales. [4]

According to Wikipedia, Earth science (also known as geoscience, the geosciences or the Earth Sciences), is an all-embracing term for the sciences related to the planet Earth. There are four major disciplines in earth sciences, namely geography, geology, geophysics and geodesy… Earth science generally recognizes 4 spheres, the lithosphere, the hydrosphere, the atmosphere, and the biosphere. These correspond to rocks, water, air, and life. Some practitioners include the cryosphere (ice) as a distinct portion of the hydrosphere and the pedosphere (soil) as an active, intermixed sphere as part of Earth's spheres. [1]

It is worth repeating here this additional information from the Wikipedia webpage on Earth Science, describing disciplines and sub-disciplines in this general topic:

- Geology describes the rocky parts of the Earth's crust (or lithosphere) and its historic development. Major subdisciplines are mineralogy and petrology, geochemistry, geomorphology, paleontology, stratigraphy, structural geology, engineering geology and sedimentology.

- Geophysics and Geodesy investigate the figure of the Earth, its reaction to forces and its magnetic and gravity fields. Geophysicists explore the Earth's core and mantle as well as the tectonic and seismic activity of the lithosphere.

- Soil science covers the outermost layer of the Earth's crust that is subject to soil formation processes (or pedosphere). Major subdisciplines include edaphology and pedology.

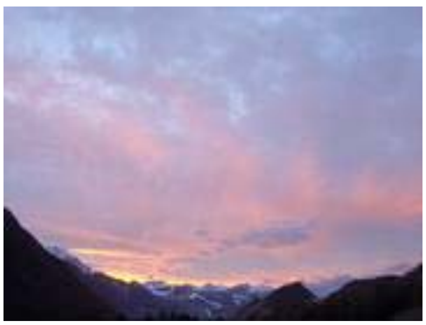
- Oceanography and hydrology (includes limnology) describe the marine and freshwater domains of the watery parts of the Earth (or hydrosphere). Major subdisciplines include hydrogeology and physical, chemical, and biological oceanography.

- Glaciology covers the icy parts of the Earth (or cryosphere).

- Atmospheric sciences cover the gaseous parts of the Earth (or atmosphere) between the surface and the exosphere (~1000 km). Major subdisciplines are meteorology, climatology, atmospheric chemistry and atmospheric physics.

- A very important linking sphere is the biosphere, the study of which is biology. The biosphere consists of all forms of life, from single-celled organisms to pine trees to people. The interactions of Earth's other spheres - lithosphere/geosphere, hydrosphere, atmosphere and/or cryosphere and pedosphere - create the conditions that can support life. [1]

Just this small introduction to Earth Sciences provides an idea of just how many topics Earth Science covers, and how many projects might be underway in these fields. Especially interesting is the list of organizations around the world dealing with the various geosciences, including geology, geophysics, oceanography, and related fields [2] Included on the list are organizations based in most large and developed countries.



In addition, the list of topics and subtopics within the Earth Sciences field reveals a huge number of scientific topics, [3] most of which are also the subject of study, research and projects at leading universities around the world.

There are many national and international programs and projects underway related to earth science research. In the USA, NASA has established an Earth Science Directorate to conduct and sponsor research, collect new observations from space, develop technologies and extend science and technology education to learners of all ages. NASA works closely with global partners in government, industry, and the public to conduct and sponsor research to answer fundamental science questions about the changes we see in climate, weather, and natural hazards, and help decision-makers make informed decisions. The purpose of NASA's Earth science program is to develop a scientific understanding of Earth's system and its response to natural or human-induced changes, and to improve prediction of climate, weather, and natural hazards. [4]

Some Big Questions

Again referring to NASA, the agency describes some “big questions” that are driving humans to invest in earth sciences, and space-based earth observation systems. Here are the big questions posed by NASA [5]:

- How is the global earth system changing? - Earth is currently in a period of warming. In the last two decades, the rate of our world's warming accelerated and scientists predict that the globe will continue to warm over the course of the 21st century.

- What are the primary forcings of the earth system? - The Sun is the primary forcing of Earth's climate system, driving almost every aspect of our world's climate system and making possible life as we know it. According to scientists' models of Earth's orbit and orientation toward the Sun, our world should be just beginning to enter a new period of cooling -- perhaps the next ice age. Humans, however, are also a new force of change affecting earth systems. Other important forcings of Earth's climate system include such "variables" as clouds, airborne particulate matter, and surface brightness.

- How does the earth system respond to natural and human-induced changes? - The second law of thermodynamics compels Earth's climate system to seek equilibrium so that, over the course of a year the amount of energy received equals the amount of energy lost to space. The equilibrium can be affected by three things: a change in the amount of incoming solar radiation; change in the abundance of greenhouse gases in Earth's atmosphere; and change in Earth's reflective features. Humans can influence only the latter two

- What are the consequences of change in the earth system for human civilization? - the temperature is rising faster now than at any other time in the history of human civilization and such rapid climate change is likely to seriously stress some populations.

- How will the Earth system change in the future? - As the world consumes ever more fossil fuel energy, greenhouse gas concentrations will continue to rise and Earth's average temperature will rise with them. Earth's average surface temperature could rise between 2°C and 6°C by the end of the 21st century. [5]

According to NASA's website, these big questions are now driving program and projects in space. In other words, NASA is funding projects and using project management to answer these questions. Examples of NASA projects in the Earth Sciences directorate are mentioned below.

Monitoring the Planet

There are many good reasons to study the planet, and especially the weather and climate change. According to NASA, over the past 50 years, world population has doubled, grain yields have tripled and economic output has grown sevenfold. Earth science research can ascertain whether and how the Earth can sustain this growth in the future. Also, over a third of the US economy - $3 trillion annually - is influenced by climate, weather, space weather, and natural hazards. [4]

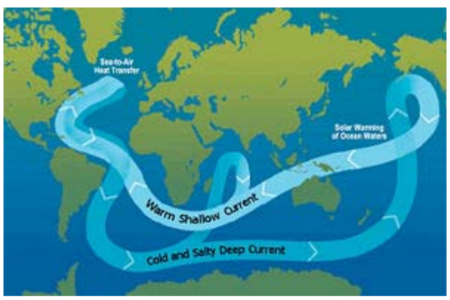
Earth Science Data Centers: NASA uses Distributed Active Archive Centers (DAACs), the data management and user services arm of NASA's EOSDIS, to store and maintain earth science data. The data centers process, archive, document, and distribute data from NASA's past and current Earth-observing satellites and field measurement programs. Each center serves a specific Earth system science discipline. NASA's current list of DAACs includes the following [6]:

- Alaska Satellite Facility DAAC (ASF DAAC)
- GSFC Earth Sciences Data and Information Services Center (GES DISC
- Global Hydrology and Resource Center (GHRC)
- Langley Research Center DAAC
- Land Processes DAAC (LP DAAC)
- National Snow and Ice Data Center DAAC (NSIDC DAAC)

- Oak Ridge National Laboratory DAAC (ORNL DAAC)
- Physical Oceanography DAAC (PO.DAAC)
- Socioeconomic Data and Applications Center (SEDAC)

Each of these centers has hundreds of data processing and database related programs and projects, involving hundreds of professionals and scientists around the world..

Again, quoting a NASA website: In the area of community preparedness for disaster management, NASA satellite missions make significant contributions in the area of hurricane and flood prediction. National Oceanic and Atmospheric Administration (NOAA) combines satellite-derived estimates of precipitation from the Special Sensor Microwave Imager (SSM/I) and from the Tropical Rainfall Measuring Mission (TRMM), with winds from QuikSCAT. Doing so substantially improves the accuracy of forecasts for landfall, track and intensity of hurricanes, and increases the lead-time for warnings for both hurricanes and floods. More accurate forecasts, in turn, enable improved decision-making leading to more enhanced community preparedness for these types of events.



The potential socioeconomic benefits of many of these applications are significant. For instance, by minimizing unnecessary emergency evacuation measures, improved hurricane forecasts save as much as $40 million for each event. Similarly, improved weather forecasting can save millions by enabling utilities to better plan for anticipated energy requirements.

For agricultural efficiency, NASA is working with the US Department of Agriculture (USDA) to explore the benefit of predictions of El Niño and La Niña events for management of farmlands. Systems used to monitor and assess the health and condition of crops and forests around the globe are being improved. The value to US agriculture industry of a "perfect" El Niño forecast is reported to be $320 million per year.

To compete in the global economy of the 21st Century, a healthy and vibrant aviation infrastructure is also needed. NASA and other space agencies work to ensure a safe, secure, efficient, and environmentally friendly air transportation system through enhancements to aviation weather forecasting. Weather is a contributing factor in approximately 30% of all aviation accidents and accounts for over 60% of all delays experienced in the air transportation system. Incorporating new, more frequent, and more precise satellite observations into weather forecasts leads to more accurate, dependable, and useful forecasts of threats to aviation including icing, turbulence, convection, and volcanic ash. [7]

According to the US Environmental Protection Agency on their Climate Change website, "the Intergovernmental Panel on Climate Change (IPCC) has stated "Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations" (IPCC, 2007). In short, a growing number of scientific analyses indicate, but cannot prove, that rising levels of greenhouse gases in the atmosphere are contributing to climate change (as theory predicts). In the coming decades, scientists anticipate that as atmospheric concentrations of greenhouse gases continue to rise, average global temperatures and sea levels will continue to rise as a result and precipitation patterns will change." [8]

Important scientific questions remain about how much warming will occur, how fast it will occur, and how the warming will affect the rest of the climate system including precipitation patterns and storms. Answering these questions will require advances in scientific knowledge in a number of areas:

- Improving understanding of natural climatic variations, changes in the sun's energy, land-use changes, the warming or cooling effects of pollutant aerosols, and the impacts of changing humidity and cloud cover.
- Determining the relative contribution to climate change of human activities and natural causes.
- Projecting future greenhouse emissions and how the climate system will respond within a narrow range.
- Improving understanding of the potential for rapid or abrupt climate change.

Addressing these and other areas of scientific uncertainty is a major priority of the U.S. Climate Change Science Program (CCSP). The CCSP is developing twenty-one Synthesis and Assessment products to advance scientific understanding of these uncertainty areas by the end of 2008. [8]

Examples of Programs & Projects

There are now thousands of projects underway in the Earth Sciences field. Here are just a few examples:

ESA – The European Space Agency (ESA) sponsors and coordinates a wide variety of international programs and projects aimed at better understanding the earth, the atmosphere, climate change and other important issues affecting the planet. For example, GENESI-DR (Ground European Network for Earth Science Interoperations - Digital Repositories), an ESA-led, European Commission (EC)-funded two-year project, is taking the lead in providing reliable, easy, long-term access to Earth Science data via the Internet. [12]

ESF – The European Science Foundation (ESF) is an association of 77 member organisations devoted to scientific research in 30 European countries. Since we were established in 1974, we have coordinated a wide range of pan-European scientific initiatives, and our flexible organisation structure means we can respond quickly to new developments. ESF's core purpose is to promote high quality science at a European level. The ESF is committed to facilitating cooperation and collaboration in European science on behalf of its principal stakeholders (Member Organisations and Europe's scientific community). This cross-border activity combines both 'top-down' and 'bottom-up' approaches in the long-term development of science. ESF provides grants, sponsors projects, organizes conferences and promotes international cooepartion on scientific research. [13]

IPY – The International Polar Year (IPY) 2007-2009 is organized through the International Council for Science (ICSU) and the World Meteorological Organization (WMO), and is actually the fourth polar year, following those in 1882-3, 1932-3, and 1957-8. In order to have full and equal coverage of both the Arctic and the Antarctic, IPY 2007-8 covers two full annual cycles from March 2007 to March 2009 and will involve over 200 projects, with thousands of scientists from over 60 nations examining a wide range of physical, biological and social research topics. It is also an unprecedented opportunity to demonstrate, follow, and get involved with, cutting edge science in real-time. [11]



NASA – According to the NASA Earth Science 2007 Senior Review, the NASA Earth Science Division (ESD) of the Science Mission Directorate (SMD) is supporting 11 Earth observing missions that are, or soon will be, operating beyond their prime mission lifetimes… data from several of these *research* missions are being used routinely by U.S. and international operational agencies in support of important Earth system prediction and monitoring tasks. Those 11 missions include Aqua, Jason, QuickSCAT, Terra, MODIS, TRMM, CloudSat, GRACE, SORCE, ICESat, and EO-1. Each mission includes dozens of projects. The FY 2009 budget for the Earth Sciences Division at NASA is $1.4 billion. [9]

NEESPI

NEESPI – The Northern Eurasia Earth Science Partnership Initiative (NEESPI) is a program based on cooperation between NASA in the USA and the Russian Academy of Science (RAS) that began in 2002. It is composed of scientists from the United States, European Union, Russia, Japan, Ukraine, Kazakhstan, and Mongolia, totally more than 90 individuals representing a broad academic community and a variety Earth Science disciplines. Scientists from 11 countries are now participating; it is envisioned that many projects will be organized or sponsored by this group. [14]

NOAA – The National Oceanographic and Atmospheric Administration (NOAA), a division of the US Department of Commerce, sponsors and finances major projects. NOAA is organized in the following divisions, each of which sponsors many projects related to studying the earth, oceans and atmosphere: National Environmental Satellite, Data, and Information Service; National Marine Fisheries Service; National Ocean Service; National Weather Service; Office of Marine and Aviation Operations; Office of Oceanic and Atmospheric Research; and Office of Program Planning and Integration. [10]

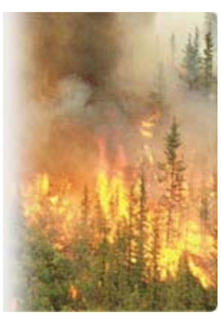
NSF – The National Science Foundation (NSF) in the United States funds research and education in most fields of science and engineering. It does this through grants, and cooperative agreements to more than 2,000 colleges, universities, K-12 school systems, businesses, informal science organizations and other research organizations throughout the United States. The Foundation accounts for about one-fourth of federal support to academic institutions for basic research. NSF receives approximately 40,000 proposals each year for research, education and training projects, of which approximately 11,000 are funded. In addition, the Foundation receives several thousand applications for graduate and postdoctoral fellowships. [15]

UNESCO - International Geoscience Programme (IGCP): Geoscience in the service of society - The IGCP is a cooperative enterprise of UNESCO and the International Union of Geological Sciences (IUGS) and has been stimulating comparative studies in the Earth Sciences since 1972. After three decades of successful work, the "International Geological Correlation Programme" continued, as "International Geoscience Programme". Up to this day, IGCP has made research results available to a huge number of scientists around the world with about 400 projects. Visit http://www.unesco.org/science/earth/igcp.shtml

Predicting Extreme Weather

According to a special report recently published by the NSF in the United States, Large-scale weather patterns which occur in various locations around the Earth, from the El Niño-Southern Oscillation (ENSO) in the tropics to the high latitude Arctic Oscillation (AO) play a significant part in controlling the weather on a seasonal time scale. Knowing the condition of these atmospheric oscillations in advance would greatly improve long-range weather predictions. Scientists search for clues in the earth's surface conditions such as tropical sea surface temperatures and snow cover at higher latitudes. Reliable and accurate weather prediction is vitally important in numerous areas of society, particularly agriculture and water management and weather risks are evaluated by a wide range of businesses, including power distributors who make fewer sales during cool summers and more sales during cold winters. [16]

According to Wikipedia, weather forecasting is the application of science and technology to predict the state of the atmosphere for a future time and a given location. Human beings have attempted to predict the weather informally for millennia, and formally since at least the nineteenth century. Weather forecasts are made by collecting quantitative data about the current state of the atmosphere and using scientific understanding of atmospheric processes to project how the atmosphere will evolve. Forecast models are now used to determine future conditions. The chaotic nature of the atmosphere, the massive computational power required to solve equations that describe the atmosphere, errors involved in measuring initial conditions, and an incomplete understanding of atmospheric processes mean that forecasts become less accurate as the difference in current time and the time for which the forecast is being made (the range of the forecast) increases. The use of ensembles and model consensus help narrow the error and pick the most likely outcome. [17]



A major part of modern weather forecasting is the severe weather alerts and advisories which weather services issue when severe or hazardous weather is expected. This is done to protect life and property. Some of the most commonly known of severe weather advisories are the severe thunderstorm and tornado warning, as well as the severe weather or the tornado watch. Other forms of these advisories include winter weather, high wind, flood, tropical cyclone, and fog. Severe weather advisories and alerts are broadcast through the media, including radio, using emergency systems as the Emergency Alert System which break into regular programming. [17]

Some of the major users of weather predictions are the aviation industry and air traffic controllers, those in marine related industries and activities, utility companies, the military, news services, governmental agencies and the general public. For extreme weather, of course emergency readiness and response organizations pay attention. Ultimately, every local, regional and national community and governmental organization has an interest in weather prediction. Suppliers of technologies, tools and services for these processes cover a wide range of hardware, software and information services entities, both public and private.

Meteorological organizations around the world provides a good list of organization most likely to have projects underway associated with weather prediction. [18]

Managing the Earth's Climate

Faced with the specter of a warming planet and frustrated by the lack of progress, some scientists have begun researching ways to give humanity direct control over Earth's thermostat. Proposals run the gamut from space mirrors deflecting a portion of the sun's energy to promoting vast marine algal blooms to suck carbon out of the atmosphere. The schemes have sparked a debate over the ethics of climate manipulation, especially when the uncertainties are vast and the stakes so high. For many scientists, the technology is less an issue than the decision-making process that may lead to its implementation.

Environmental policy driven purely by cost-benefit analyses cannot, they say, effectively point the way on large issues like climate change. But even as many scientists caution against unintended, even catastrophic consequences of tinkering with climate, they concede that the more tools humankind has to confront a serious problem, the better. Others wonder if the mere hint of a quick-fix solution will only provide a false sense of security and hamper efforts to address the root problem: carbon emissions from a fossil fuel-based economy. And then there's the trillion-dollar question: In a politically fractured world, how will technologies that affect everyone be implemented by the few, the rich, and the tech-savvy?

When scientists talk about geo-engineering, they generally mean subtracting a fraction of the sun's energy from the earth equal to that trapped by human-emitted greenhouse gases. It is not a new idea, but only recently has it moved toward the scientific mainstream. In 2006, Nobel Laureate Paul Crutzen of the Max Planck Institute for Chemistry in Mainz, Germany, published a paper on injecting particles into the upper atmosphere to reflect incoming sunlight and cool the earth. Climate scientists have since run scenarios on climate models and first reports found that it might work. In November 2006, NASA co-hosted a conference on the topic. [19]

Planetary climate control, or at least attempts to manage extreme weather, is a topic that is "on the table" now. It may have been the subject of science fiction a few years ago, but it is a serious discussion today. I believe that programs and projects will soon be launched to explore or even implement new approaches to affecting the weather. I believe these programs will involve massive funds, global cooperation, and professional project management. Just as nations are now spending billions on astronomy and space exploration, so too will we all be spending public funds on better meteorology, weather prediction and climate management.

The Potential Impact

The potential impact of a better understanding of the earth, our atmosphere and climate is significant, on many fronts. While climate change and extreme weather have become highly visible topics in the media in recent years, this year agriculture and food supplies has entered a near crisis stage, primarily due to high energy costs. According to the United Nations (UN), upgrading and improving weather services will play an important role in helping ensure food security in poorer countries at risk from the impact of climate change and natural disasters.

Speaking at a round-table discussion on food security in late June at the Global Humanitarian Forum in Geneva, World Meteorological Organization (WMO) Secretary-General **Michel Jarraud** (pictured at left) said enhanced preparation and awareness of meteorological problems and challenges would allow policymakers to respond better once a disaster strikes.

Mr. Jarraud said WMO was working, through its regional climate centres and other agencies, to improve prevention and preparedness measures, including risk assessment, early-warning systems and emergency planning.

Natural disasters such as floods and droughts are among the biggest causes of what is known as "transitory hunger," compared to poverty-induced "chronic hunger." Although natural hazards cannot be avoided, capacity-building and prevention measures can greatly reduce their impact and ensure that people have enough food stocks to last them through a crisis. [20]

Both the UN and the World Bank have committed recently to investing in improving meteorological services and weather forecasting capabilities in Africa.

Some Resources

Here are some useful and interesting resources related to Earth Sciences, monitoring the planet and weather management.

The American Geological Institute is a nonprofit federation of 44 geo-scientific and professional associations that represents more than 100,000 geologists, geophysicists, and other earth scientists. Founded in 1948, AGI provides information services to geoscientists, serves as a voice of shared interests in our profession, plays a major role in strengthening geoscience education, and strives to increase public awareness of the vital role the geosciences play in society's use of resources and interaction with the environment. http://www.agiweb.org/index.html

The Center for International Earth Science Information Network (CIESIN) is a center within the Earth Institute at Columbia University in New York. CIESIN works at the intersection of the social, natural, and information sciences, and specializes in on-line data and information management, spatial data integration and training, and interdisciplinary research related to human interactions in the environment. http://www.ciesin.org/

Earth Science Directory - a directory of earth science resources on the World-Wide Web - is built from a database which is constantly being expanded and updated. It is strongest in oceanography and meteorology and now contains 979 different links!
http://www.datasync.com/~farrar/earth_sci.html

Implications for Project Management

The broad implications of all of the above for project management should be obvious. Thousands of projects costing billions of dollars are being launched today to better understand the planet, to predict the weather and future climate change, and to develop models, technology and information that can help humans better manage the planet in the future.

Every organization involved in any aspect of these technologies and projects will need project management; the larger ones (the government contractors, for example) will employ professional project managers and harness professional PM. This is clearly a growing market for PM products and services, and for employment. Public pressures to provide better weather predictions and to prepare for extreme weather are also propelling this sector. And if extreme weather or climate change can be "managed", the pressure will only increase.

This discussion was not intended to be a comprehensive assessment of climate change, earth sciences or related issues, or even the opportunities in this sector for project management. It was, however, intended to suggest these fields as a new frontier, where increased need and demand for professional project management should be robust in the years ahead.

In any case, I am optimistic, actually excited to see another important area of human activity where modern project management can make significant contributions.

Good luck on your projects!

David L. Pells
Managing Editor
www.pmforum.org
www.pmworldtoday.net

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David L. Pells
Managing Editor
PM World Today
PMForum, Inc.

David L. Pells *is the Managing Editor of PM World Today and of www.pmforum.org, one of the world's leading online sources of project management news and information. David is an internationally recognized leader in the field of professional project management, with over thirty years' experience in project management. His professional experience includes a wide variety of programs and projects, including engineering, construction, transit, defense and high technology, and project sizes ranging from several thousand to ten billion dollars. He served on the board of directors of the Project Management Institute (PMI®) twice, and was awarded PMI's Person of the Year award in 1998 and Fellow Award in 1999. He has published widely and speaks at PM conferences and events worldwide. David can be reached via email at: editor@pmforum.org*