Public Written Comments

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Comment from the PCAST Website

05/11/2012 - 12:09pm
Gerardo Paredes
[redacted]

As promised , I am sending to you , my Paper Tricotomy.

Respectfully

TRICOTOMY.

α_1

For $a > b$, see my

Paper: Mathematical Entropy.

TAKING A GROUP OF NUMBERS 1's and denote THEM AS A = $a_1, a_2 \ldots a_n$ AND B = $b_1, b_2 \ldots b_n$.

IF A GROUP OF NUMBERS a HAS LESS ELEMENTS THAN A GROUP OF NUMBERS b ALL EQUALS AMONG THEM, THEN WE HAVE THAT THE GROUP a IS SMALLER THAN b IF.

SET A < SET B.

IN NUMBERS

$$1+1+1+1 < 1+1+1+1+1+1.$$

LET THE SET A EQUAL TO a_1, a_2, a_3, a_4 AND LET THE SET B = $b_1, b_2, b_3, b_4, b_5, b_6$

WHERE

$a_1 = b_1$

$a_2 = b_2$

$a_3 = b_3$

$a_4 = b_4$

WE HAVE IN SET B THAT b_5, b_6 DO NOT HAVE ELEMENS IN COMMON IN SET A. THEN WE CAN SAY THAT A < B and

$$a_1, \ldots a_n < b_1, \ldots b_m$$

$$n < m.$$

IN THE CASE $a = b$ 24

IT IS CALLED AN AUTOMORPHISM.

1) INNER AUTOMORPHISM:

IF THERE IS A FIXED ELEMENT a OF THE GROUP SUCH THAT, FOR ANY ELEMENT x

$a x a^{-1}$ IS THE

ELEMENT CORRESPONDING TO x, WE HAVE AN INNER AUTOMORPHISM.

2) IF $B_1 \longrightarrow B_2$, $B_2 \longrightarrow B_1$,

$1 \longrightarrow 1$

THE GROUP $(B_1, B_2, 1)$

IS AN OUTER AUTOMORPHISM.

Comment from PCAST Website
05/17/2012 - 5:43pm
Jeff Corwin
[redacted]

I enjoyed the presentation that John Holdren gave at the University of Virginia this afternoon.

I'd like to ask whether your office is investigating what has been driving the increases in tuition at top colleges and universities in the U.S. I expect that you are aware of editorials and graphs produced by the Goldwater Institute that propose that the primary driver for tuition increases has been the costs of increasing administrative components at highly ranked colleges and universities. (Please see the uploaded document.)

If that is true, as many faculty suspect, it may be useful to come out with statements about that, so as to encourage colleges and the boards that set policies to begin addressing that issue.

Thanks again for a stimulating presentation and Q & A session.

-Jeff Corwin

Colleges Feeding Administrative Bloat

Print Page

Posted on August 25, 2010 | Type: Op-Ed | Author: Jay P. Greene

As students return to college this fall, parents and taxpayers are probably wondering where all of the money we give to universities actually goes. They may be disappointed to discover that administration is consuming a large and rapidly growing portion of university resources.

Resources devoted to instruction, research and service — the primary functions of a university — are growing much more slowly.

In a recently released report for the Goldwater Institute, we examined data collected by the federal government from the country's leading 198 public and private universities, and looked at the growth in executive and professional staff as compared to instructors and researchers. The results are disturbing.

In 2007, nearly 39 percent of all full-time employees at these universities were engaged in administration, an increase of 39 percent from the number of administrators per 100 students in 1993. Only 29 percent of full-time employees were engaged in instruction, research and service, an increase of 18 percent since 1993.

One might think that as enrollments increase, universities would need relatively fewer administrators per student, since they could spread those fixed costs over a larger base. Instead, the opposite is occurring.

As universities increase their enrollment and receive more money, they expand the ranks of administrators even more rapidly. Rather than achieving economies of scale in administration so that more resources can be redirected to core functions, America's leading universities increased administration significantly faster than enrollment and almost twice as fast as teaching, research and service.

Georgia's public universities have not escaped this problem of administrative bloat. At the University of Georgia the number of full-time administrators per 100 students grew by 43 percent between 1993 and 2007, compared to only a 3 percent increase in teaching, research and service.

At Georgia State University, the number of full-time administrators per 100 students grew by 51 percent between 1993 and 2007, while full-time employees engaged in instruction, research and service grew by only 16 percent. We see the same story at Georgia Tech, where administration increased by 51 percent compared to a 9 percent decline in teaching, research and service.

Why would universities give such priority to administration? The simple answer is that they do so because they can. As long as parents and students are willing to pay ever-increasing tuitions and taxpayers are willing to continually increase subsidies for higher education, university administrators will be able to direct those resources in the way they prefer.

And not surprisingly, administrators tend to prefer hiring ever-more administrators and paying those administrators ever-higher salaries.

Unfortunately, the politically attractive policy of increasing federal and state subsidies for higher education exacerbates the problem. Because policies such as direct state and federal appropriations to higher education insulate families from the full financial burden of administrative bloat, those families are less sensitive to university costs and administrators face less pressure to economize.

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There is a vicious circle — universities pass along the cost of administrative bloat to consumers in the form of higher tuition, which causes families to demand higher subsidies from the government, which enables even higher administrative costs and tuition rates.

As painful as it may be at first, the only way to break this vicious circle is to reduce government subsidies of higher education. As of 2007, tuition only generated about a quarter of total university spending, the rest coming from some combination of direct government subsidies, donations and fees for services.

If tuition had to cover a larger share of university expenses, families would be more cost-conscious and force administrators to trim administrative expenses while concentrating resources on their core missions of teaching, research and service.

We have an example of where this has been accomplished. At the University of Michigan, state funding dropped to less than 10 percent of total revenue. Between 1993 and 2007, the University of Michigan was one of the few leading universities that actually reduced the number of administrators, cutting the number per 100 students by 5.5 percent. Of the universities we examined, Michigan had one of the lowest increases in administrative spending.

Georgia's universities may howl that they pinch every penny, but when faced with cuts in government subsidies they'll discover greater efficiencies and reduce administrative bloat, just as Michigan did. It won't be easy, but there is no other way to control runaway costs in higher education.

Jay P. Greene is a senior fellow at the Goldwater Institute and the 21st century professor of education reform at the University of Arkansas, where Brian Kisida and Jonathan Mills are research associates.

Comment from PCAST Website
05/23/2012 - 5:40am
Prof. Curt M. Breneman
Rensselaer Polytechnic Institute
[redacted]

[Based on contact made with Dr. Cyrus Wadia and others in the OSTP during the May 14th, 2012 White House Materials Genome Initiative Kickoff meeting]

During a conversation with members of the OSTP at the MGI meeting, it became clear that in addition to innovations in Materials and advanced manufacturing, there was interest in the emerging field Biomimicry for the design of new materials and other design areas. In response to those conversations, I'm attaching a short whitepaper report on Biomimicry which describes how NYSERDA, Rensselaer and other organizations in New York State and beyond have been advancing this economically stimulating effort.

Sincerely,

Curt M. Breneman
Professor and Head
Department of Chemistry & Chemical Biology
Rensselaer Polytechnic Institute

Biomimicry in New York State and Beyond: A Brief Overview

Miriam Pye, Dana Levy, New York State Energy Research and Development Authority (NYSERDA)
Siobhan Watson, Chris Garvin, and Namita Kallianpurkar, Terrapin Bright Green
Nicholas Beck, Biomimicry 3.8

"The more our world functions like the natural world, the more likely we are to endure on this home that is ours, but not ours alone." ~ Janine Benyus

Biomimicry – the conscious emulation of nature – is both a methodology and a design mindset that helps identify and solve problems in areas such as energy performance, efficient use of water, toxin reduction, and waste elimination. It points the way to advancements that are essential to ensuring the long-term competitive success of US companies and to creating more jobs in the US. A 2010 study by Point Loma Nazarene University suggests that in 15 years biomimicry could represent $300 billion annually of US GDP in 2010 dollars. It could provide another $50 billion in terms of mitigating the depletion of various natural resources and reducing CO_2, and could account for 1.6 million US jobs by 2025. Globally, biomimicry could represent about $1 trillion of GDP in 15 years. A cursory look at the literature reveals that federal agencies spanning from DOE to NSF, DARPA, the US Navy, and NASA have all supported a number of biomimicry R&D projects with tens of millions in funding in recent years.

NYSERDA, Terrapin Bright Green, Biomimicry 3.8 are working to spur energy-related biomimetic innovation in New York State. Through a NYSERDA-funded program, we are engaging manufacturers throughout the state and introducing them to the concept of mimicking natural forms/high-performance materials, processes, and systems to create innovative new products and techniques in an industrial setting. In this paper, we show the resources that nature holds for industrial innovations, particularly in energy efficiency; we demonstrate that companies can use biomimicry to be successful; and we describe the process that our team is developing to spur biomimetic innovation in New York State.

Looking to Biology for Innovation: Form, Process, Ecosystem

Biomimetic designs use the natural world for inspiration in a variety of ways. First, and most intuitively, biomimicry uses natural forms to inspire the form of manufactured products. Second, biomimicry uses natural processes as models for manufacturing processes. Finally, biomimicry uses ecosystem-level interactions to inspire the organization of human and industrial systems. Companies have used each of these levels of biomimicry to transform traditional research and development methods. Rather than working incrementally on improving existing ideas, biomimicry can provide entirely new ideas that can be integrated into companies' products and operations in novel ways.

Form

In a successful example of finding inspiration in natural form, Pax Scientific mimicked a form commonly found in nature to achieve impressive energy efficiency gains in rotational equipment. Traditional fans, pumps, and propellers consist of planar surfaces, or surfaces with simple curvature in only one axis. They use these geometries to generate centrifugal forces—forces moving outward from the center of rotation. These forces generate turbulence that moves or mixes the gas or fluid. Design faults include drag resistance, low output, energy inefficiency, excessive noise, and component wear and tear.

Jay Harman, the founder of Pax, noticed a recurrent geometry in nature: from water flows, to kelp patterns, to shell architectures, nature repeatedly utilizes 3-dimensional centripetal spirals—oriented toward the center of curvature—for liquid flows. Harman reverse engineered this geometry and created a fan half as noisy, 75% more efficient, with markedly decreased vibration. Further tests demonstrated that the approach could be applied to fluids of all types. One of the most successful applications of the technology is in drinking-water utilities, where Pax's Lily Impeller (Figure 1), is able to prevent the formation of biofilm through efficient, low-energy, continuous mixing in water tanks. Prior to Pax

technology, mechanical systems for mixing drinking water and preventing biofilm formation used too much energy to be cost-effective for the utilities. Pax allows utilities to maintain high drinking water standards with fewer chemicals and efficient use of energy.

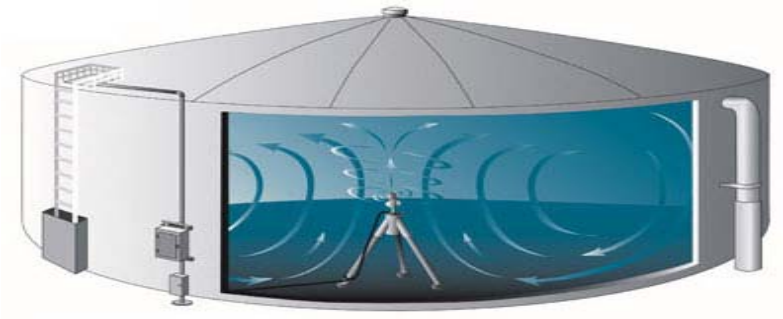

Figure 1. Movement created by the Pax Lily Impeller
The PAX Water Mixer's Lily Impeller is designed using computational fluid dynamics to reverse engineer the creation of whirlpool flows found in nature.

Process

Inspiration from natural processes has made many contributions to industry. A potentially transformative example is the inspiration that Calera Corp. derived from the process by which coral reefs are formed from carbon dioxide (CO_2) and minerals in ocean water. Modeling the ocean chemistry that allows this to take place, Calera developed a process called Mineralization via Aqueous Precipitation (MAP), illustrated in Figure 2, which bubbles CO_2-laden gases through water, then precipitates the CO_2 to form bicarbonate, calcium carbonate, and magnesium carbonate. Calera produces cements, supplementary cementitious materials, and synthetic limestone using MAP, which can replace mined building materials.

Calera's potential to replace cement is particularly important, as the production of Portland cement represents the third largest anthropogenic source of CO_2 production. Calera is scaling its operations to be able to sequester CO_2 from coal-fired power plant flue gases, and expects to be able to trap more than 70% of gases released from power plant stacks. This process would make Calera products carbon-negative building materials.

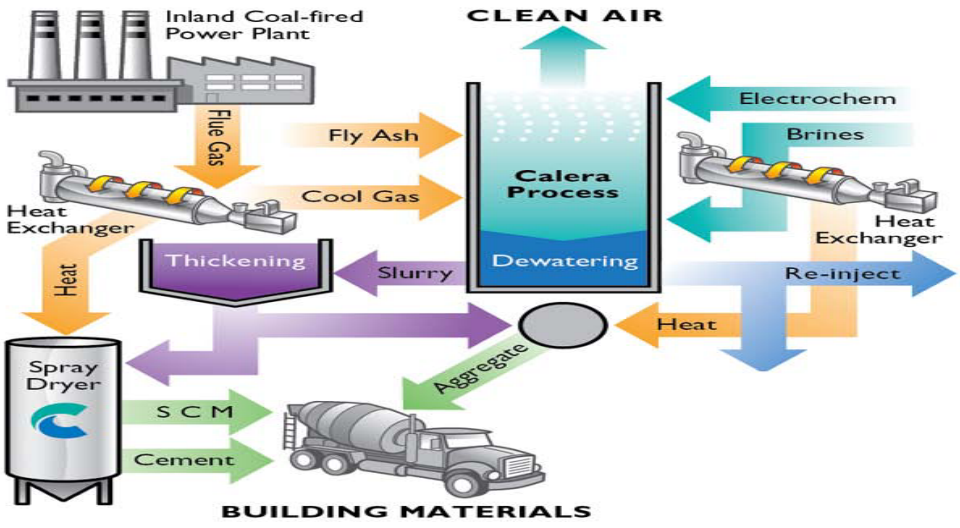

Figure 2. Calera Process
Mineralization via Aqueous Precipitation mimics the process of coral reef formation in ocean water.

Ecosystem

Ecosystem-level interactions in nature provide models for how to organize industrial and human systems on a broader scale. The concept of Industrial Ecology is inspired by the ecological principle that one organism's waste product provides another's feedstock, such as fungi that make use of decomposing plant matter for their growth. Kalundborg, Denmark, is the most well-known example of a successful industrial ecology system. Kalundborg is anchored by five main entities that exchange flows of materials and energy to produce efficiencies: Asnaes Power Station, a 1500-MW coal-fired power plant; an oil refinery operated by Statoil; Novo Nordisk, a pharmaceutical company; Gyproc, a plasterboard manufacturer; and the municipality of Kalundborg.

Asnaes provides its waste heat to the municipality in the form of steam heat; in its first 15 years, this system eliminated the use of 3,500 oil-fired residential furnaces and provided reliable, inexpensive heat to homeowners. Asnaes also provides steam to Novo Nordisk, and provides gypsum, made from calcium sulfate produced by the power plant's sulfur dioxide scrubber, to Gyproc. Statoil, which previously flared waste gases, now provides them to Gyproc, fulfilling all of Gyproc's power needs. Statoil also provides cooling water to Asnaes, where it becomes boiler-feed water, reducing water demand 25%. Novo Nordisk produces a nutrient-rich sludge by-product from its pharmaceutical operations, which it distributes to local farms as a fertilizer.

These and other interactions create a web of material and energy exchanges within Kalundborg, but each interaction was created as an independent business relationship between parties. Kalundborg's industrial ecosystem is a model for other industrial parks attempting to improve their environmental performance.

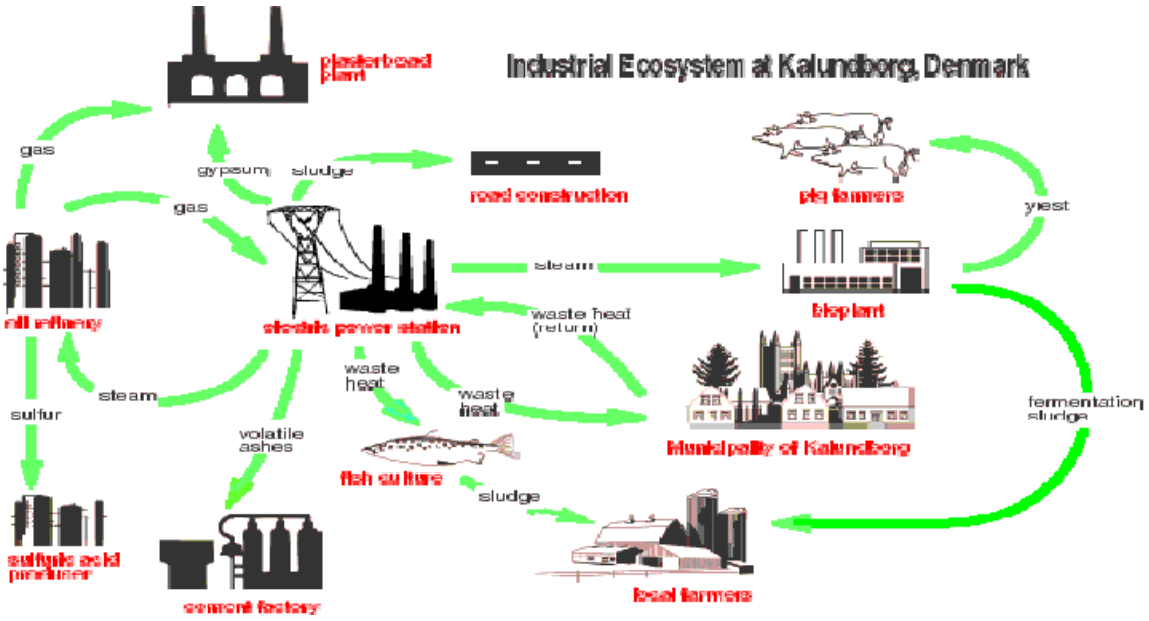

Figure 3. Industrial Ecosystem at Kalundborg, Denmark

Commercialized and Emerging Biomimetic Innovations

Our program aims to move companies closer to biomimetic innovation. In order to do this, we set out to understand the various ways in which companies have achieved financial success as well as environmental improvements using biomimicry. Here, we show just a few examples of commercialized and emerging biomimetic innovations.

Novomer, LLC,
Novomer, in Ithaca, NY, is commercializing a proprietary catalyst system that transforms waste CO_2 into high performance, low-cost polymers for a variety of applications. NYSERDA funded initial research, which is biomimetic because it mimics photosynthesis' utilization of CO_2 as a feedstock. Polymers created by Novomer use CO_2 to replace up to 50% of the petroleum feedstock typically used in plastic production. This helps sequester this greenhouse gas and because CO_2 is an inexpensive starting material, it allows Novomer to create cost-competitive products.

Ecovative
Just as nature grows materials, Ecovative, in Green Island, NY, grows products that can replace materials ranging from petroleum-based expanded plastics (like Styrofoam™) to particle board made using carcinogenic formaldehyde. Their materials are 100% renewable, and primarily made from agricultural byproducts and mycelium, a fungal network of threadlike cells which act like a natural, self-assembling glue. These low-embodied energy materials can be composted when no longer needed. NYSERDA has co-funded Ecovative's R&D on multiple products and projects.

SunPoint Technologies, Inc.
SunPoint is a new company, formed to develop and commercialize a heliotropic solar tracker that increases energy conversion efficiency by up to 23% relative to fixed panels. This robust, low-cost tracking system mimics plants that are heliotropic, tilting toward the sun throughout the day to maximize solar energy capture by using a simple system of thermally active metal strips that bend and tilt a photovoltaic (PV) panel toward the sun as it moves from east to west, optimizing solar energy capture.

NYSERDA provided a letter of support for SunPoint's proposal to the Department of Energy (DE-FOA-0000651). If SunPoint is funded through this DOE solicitation, NYSERDA will contribute $100,000 in cash cost share if SunPoint locates in New York State. The objective of SunPoint's project is to optimize their Heliotropic tracker model designs, reduce fabrication material, maximize the system's energy output and compile data to validate performance.

Sun Catalytix Corporation
Photosynthetic light reactions split a water molecule into hydrogen and oxygen. This biochemical pathway is complex and difficult to reproduce. In addition to untangling these multielectron photo-reactions, Daniel Nocera's MIT research group demonstrated proton-coupled electron transfer using superfast lasers for measurement. They developed a suite of photocatalysts that produce hydrogen from diverse water sources. Sun Catalytix was founded to advance these achievements and develop them into commercial products. With Nature as its inspiration, they seek to combine sunlight and water to provide affordable, highly distributed renewable energy. The elemental components of three gallons of water have enough energy, when recombined, to satisfy the daily energy needs of a large American home.

The Dinolfo group at Rensselaer Polytechnic Institute in Troy, NY, is developing bio-inspired, nanoscale molecular devices that will allow for efficient conversion of sunlight into electricity and stored solar energy in the form of chemical fuels. Similar to photosynthesis, this process will use sunlight to drive the splitting of water into high energy chemicals such as oxygen and hydrogen which can then be recombined in fuel cells or used to create other energy rich fuels. This technology has the potential to provide a clean, carbon-free renewable energy source for a wide variety of applications.

Eastgate Center and Termite Mounds
Termites construct mounds that maintain a constant internal temperature of 87°F (optimum temperature for the fungi these termites cultivate) while the temperature outside ranges from 35° - 104°. Termites do this by creating narrowing shafts rising through the mound that channel and accelerate the release of warm internal air out vents at the mounds' top; and openings at the base of the mound that allow cooler, denser air to flow in replacing warmer air as it rises. These principles informed the design of the Eastgate

Center, built in Zimbabwe in 1995, which uses about 35% of the energy required for temperature regulation as similar conventional office buildings and saved building owners $3.5 million up-front, because they did not need to buy an air conditioning system for the building.

SUNY Environmental Science and Forestry (ESF) Professor J. Scott Turner is the lead scientist on an international team of researchers that has received a $1.35 million grant to explore the basic science of the structure and function of termite mounds. The funding from the Human Frontiers Science Program (HFSP) builds on Turner's pioneering research on the mound-building termites of southern Africa.

REGEN Energy
REGEN Energy™ created EnviroGrid™, a wireless energy management solution that is quickly installed and can cut electric costs 5-10% or more. EnviroGrid™ is based on "swarm logic," the way that bees communicate and coordinate with each other using simple rules. EnviroGrid™ controllers establish a mesh wireless network, and communicate among themselves autonomously. Using their algorithm, the devices spread out energy demand between devices, resulting in peak demand shaving, substantial energy savings, and reduced pressure on the electric grid.

WhalePower
WhalePower developed a more energy-efficient fan and wind-turbine blade design using tubercle technology, inspired by humpback whale flippers, which have tubercles or bumps on the leading edges. Current wind turbine blades require steady, high winds to generate electricity. The tubercle technology wind-turbine blades require lower wind speeds, increasing the amount of time and the number of locations where they can actively generate electricity.

NYSERDA Program Process

Given the potential benefits that biomimicry can bring to companies, NYSERDA is beginning to help New York State companies innovate and reduce their energy costs by using biomimicry as a design process. Terrapin, Biomimicry 3.8, and NYSERDA are crafting a process designed to bring New York State companies closer to creating biomimetic innovations and incorporating existing biomimetic products and processes into their operations. The program includes multiple levels of involvement with companies, from general presentations through individual focused consulting and matchmaking that may not initially be intuitively obvious. Through participation in each level of involvement, a company will gain increasing levels of benefit from the program.

We believe that US industries will benefit tremendously from increased awareness and use of biomimicry as a tool for innovation and energy efficiency. Building systems, chemistry companies, and battery and energy storage technologies are just some of the industries that could benefit from biomimicry. Our program is designed to identify these intersections and promote the adoption of efficient, economically advantageous biomimetic technologies in New York State.

Selected Biomimicry in the News

Forbes, May 21, 2012: Amoeba-Through-Zebra Innovation

GreenBiz.com, Jan. 5, 2012: The Year in **Biomimicry**: How Beetles, Mantis Shrimp & More Inspired**...**

Harvard Business Review, 2009: The Business of Biomimicry

Smithsonian.com, August 17, 2012: How Nature Makes Us Smarter

National Geographic, April 19, 2012: Pictures: Nature Yields New Ideas for Energy and Efficiency

Clean Technica, April 28, 2012: Powerhouse Solar Cell Inspired by Leaf **Biomimicry**

Nanotechnology News, March 14 2012: Innovations That Could Change the Way We Manufacture Society of **...**

Comment from the PCAST Website
05/28/2012 - 9:41am
Frederick Mayer
MARI
[redacted]

Dear Dr Holdren,

I am forwarding our recent IJTP paper that sets the stage for a possible new direction in energy generation. I have been involved in fusion programs both magnetic and inertial for over 50 years. The possibility for bringing the "excess" heat from the Earth (about 44 TWs) to the surface looks likely but even getting our work published has been quite difficult given the many vested interests involved. I would be pleased to brief you on this work in depth if you so choose. Regards,

-Fred Mayer

Frederick J. Mayer, PhD, President
Mayer Applied Research, Inc.
[redacted]

Electromagnetic Composites at the Compton Scale

Frederick J. Mayer & John R. Reitz

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Electromagnetic Composites at the Compton Scale

Frederick J. Mayer · John R. Reitz

Received: 30 June 2011 / Accepted: 8 September 2011 / Published online: 23 September 2011

Abstract A new class of electromagnetic composite particles is proposed. The composites are very small (the Compton scale), potentially long-lived, would have unique interactions with atomic and nuclear systems, and, if they exist, could explain a number of otherwise anomalous and conflicting observations in diverse research areas.

Keywords Electromagnetic composites · Compton scale · Bound states · Formation energy

1 Introduction

In recent years there have been a number of experimental observations that are difficult to explain within our now-standard models of atomic and nuclear physics and cosmology. The case of so-called "dark matter" is an example. It appears that only a small fraction of the mass of the universe is constructed from ordinary protons, neutrons, and electrons. So, many cosmologists have turned to some relic elementary particle as the candidate to complete the mass deficit. Strange observations such as the excess heat from the earth and "cold fusion" are still other examples. We have wondered if there might be configurations of nucleons and electrons that would not be directly observable in the same way as are the ordinary nucleon atomic systems. This consideration was the genesis of the work presented here.

The possibility of new electromagnetic bound states in which the magnetic and electric forces are treated equally and are of comparable size was suggested in our recent paper [1]. For example, the electrostatic force between two electrons e^2/r^2 is comparable with the dipole-dipole magnetic force μ_e^2/r^4 at a distance $r \approx \lambda_c$, where λ_c is the electron Compton wavelength. In fact, a number of bound states involving two electron-like particles were

F.J. Mayer (✉)
Mayer Applied Research, Inc., [redacted]

J.R. Reitz
[redacted]

found as solutions to the Dirac equation. However, none of these states involved nucleons because the nuclear magnetic moments are too small to produce binding. Yet, it seemed plausible that composites that included nucleons might be possible at the Compton scale. These composites might resemble normal atoms perhaps with different characteristics, but would be, of course, much smaller than atoms.

In this paper, we propose simple composite systems that include nucleons but are still bound together by comparable electric and magnetic forces. These entities make up a three-body system which is too complicated to treat rigorously in a quantum mechanical manner, so we present a simple Schrödinger model (one which is consistent with its Dirac equation origin) to get quantitative estimates of the system's size and binding energy. Clearly, without a quantum electrodynamical formulation for these composites, their existence is unproven; however, since these entities appear plausible, we will look at the consequences as if they do exist.

We first describe several model calculations for these three-body systems and determine whether bound states appear possible. Second, we examine the situations in which these composites might be expected to be formed. Finally, we connect the characteristics of the proposed composite particles to a number of anomalous observations over the past years. In a later papers, we will consider such anomalous observations in detail.

2 The Electromagnetic Configuration

The simplest classical model of one of these three-body systems consists of a positively charged nucleus (Ze) and two "point" electrons on opposite sides of the nucleon. The electrons have their customary magnetic moment $\mu_e = e\lambda_c/2$. The nucleon provides the attractive electrostatic force pulling the electrons together; the electrons repel each other electrostatically and magnetically through the dipole-dipole interaction. The electronic motion must be highly correlated—i.e., the electrons move in such a way that they stay apart as far as possible, consistent with maximizing their interaction with the nucleon. Is this a possible configuration at the Compton scale, i.e., is the electron magnetic moment developed to the point that $\mu_\mathbf{e} \cdot \mathbf{B}$ represents an appropriate energy term? There is no such term in the Dirac equation, only a vector potential that interacts with the electronic motion. However, Schiff [2] shows that the Dirac equation for an electron in an electromagnetic field is equivalent to a Schrödinger equation with the usual $\mu_\mathbf{e} \cdot \mathbf{B}$ term [Schiff's Eq. (43.27)] if $2mc^2 \gg E' - e\phi$ where $E' = E_{total} - mc^2$. This turns out to be the case for the model considered herein.

Of course, one aspect of the electronic motion predicted by the Dirac equation does not appear in the Schrödinger equation, namely, the *zitterbewegung* [3, 4]. This motion occurs on a very short time scale, is confined to small distances (of the order of λ_c), does not affect the classical trajectory, and is believed to be responsible for creating the electron-spin magnetic moment. However, the *zitterbewegung* must traverse distances of at least one Compton in order to develop the observed magnetic moment. The classical models described below have equilibrium radii smaller than this, so the magnetic moments cannot be treated as point entities in any final picture.

There are two cases with no orbital angular momentum. In the first case, the electrons are located equatorially, on opposite sides, at distance r from a nucleon Ze—see Fig. 1(a).

We neglect the nuclear magnetic moment. Consider the case where the total angular momentum is zero, i.e., when one electron's particle momentum is canceled by the magnetic

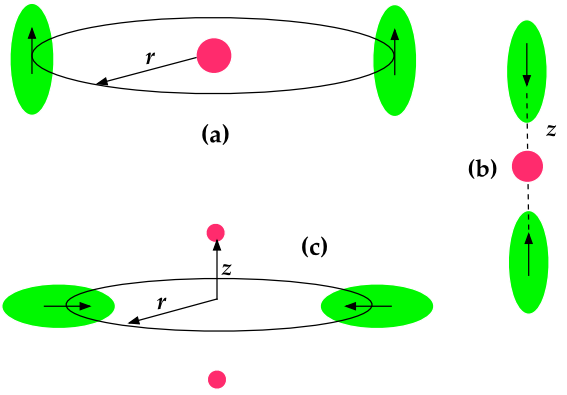

Fig. 1 (Color online) Compton composite "classical" depictions showing protons (*red*) and electrons (*green*)

field momentum of the other electron.

$$n\hbar = r(mv + (e/c)A_\phi) = mvr - (e/c)\mu_e/4r = 0 \tag{1}$$

where μ_e is the electron's magnetic moment. The centripetal force equation for one of the electrons is then

$$mv^2/r = Z_{eff}e^2/r^2 - (e/c)\mu_e v/8r^3 - 3\mu_e^2/16r^4 \tag{2}$$

where $Z_{eff} = Z - 1/4$. Equation (1) gives

$$\beta = v/c = \alpha/8r^2 \tag{3}$$

where α is the fine structure constant, and (*Note*), from here and henceforth, distances are measured in units of λ_c, and energies in units of $E_c = e^2/\lambda_c = 3.7$ keV. These equations will show that $\beta \ll 1$. The total electromagnetic energy of this system is

$$W_{\rm em} = -2\,Z_{eff}/r + 1/(32\,r^3). \tag{4}$$

Solving (1) and (2) gives $r = \sqrt{3/Z_{eff}}/8$. This system has a total electron spin of 1. With $Z = 1$, $r = 1/4$, and the binding energy $E_{\rm B} = 4$.

In the second case—see Fig. 1(b), the electrons are located on the z-axis at $+z$ and $-z$, with the nucleon at the origin. The total electromagnetic energy of the system as a function of z (the electron-nucleon distance) is

$$W_{\rm em}(z) = -2Z_{eff}/z + 1/16z^3. \tag{5}$$

This has a minimum at $z = \sqrt{6/Z_{eff}}/8$; for $Z = 1$, $z = 0.354$. We note that this represents a potential which is about 10 keV deep at an electron-nucleon distance of about one third of a Compton. In addition to $W_{\rm em}$ there is also kinetic energy, presumably due to vibration.

Summarizing, we have found two (classical) bound states for three-body electromagnetic composites: a compact equatorial state with spin 1 and a binding energy of about 15 keV (for $Z = 1$), and a more loosely-bound axial state with spin zero. But the classical models cannot provide a valid picture. The deBroglie wavelength is not short enough to localize an electron in a fraction of a Compton.

What is required is a non-perturbative QED treatment of the three-body system, but this is not presently available. We can, however, solve a simplified Schrödinger model. Here, again, we note that the deBroglie wavelength is not short enough to keep the electrons apart and at the same time localize them in the Compton range. Thus, the electron wave-functions must overlap, so that an $S = 0$ spin state is required.

The *zitterbewegung* loops can form around any axis; there is no net spin and hence no preferred axis. In writing a Schrödinger Hamiltonian for one of the electrons we choose a Hartree model [5] in which the electron under consideration is a "point"-electron e_1 interacting with a nucleus and the electron distribution of e_2 (electron-2). The Hartree field model is a central-field model, so we can use spherical coordinates. We make two assumptions to differentiate this new type of wave-function from the atomic case: the magnetic interaction between the electrons plays an essential role, and the electrons are completely correlated so that r_1 equals $-r_2$ at any instant. Since the two electrons in this model have the same wave-function we can just as easily solve a Schrödinger equation for the 2-*electron system*; this takes the form:

$$\left[\frac{\partial^2}{\partial r^2} + \alpha[E - V(r)]\right]\psi(r) = 0 \tag{6}$$

where α is the fine structure constant, E is the eigenvalue (the particle binding energy is $-E$), and the potential $V(r)$ is given by:

$$V(r) = \frac{1}{4(1+4r^2)^{\frac{3}{2}}} + \frac{1}{\sqrt{1+4r^2}} - \frac{2\,Z}{\sqrt{r^2 + {r_n}^2}} \tag{7}$$

where r_n is the nuclear radius in Compton units.

The first term in (7) is the magnetic interaction between the electrons. To calculate this we need the axial magnetic field of a loop, and this can be obtained from expressions derived by Smythe [6]. The spin dipole is produced by swirling *zitterbewegung* currents with dimensions of order of λ_c, this swirl of currents around the image point of r_1 forms the electron distribution of electron e_2.

The result of our quantum mechanical calculation is as follows: the two one-electron wavefunctions overlap and have strong maxima at the origin (the nucleus). Taking $Z = 1$, the wavefunction ψ (squared) is shown in Fig. 2 where the average value of r is about six Comptons and the particle binding energy, $E_B \approx 1$, or about 3.7 keV.

3 Characteristics of Hydrogen Tresinos

For convenience, we have given these three-body electromagnetic composites the name *tresinos*. In this section we discuss the properties of the hydrogen tresinos (the $Z = 1$ case). Where and under what conditions might they be formed and will they survive for some length of time? Clearly, the physical conditions favoring tresino formation require a nucleon and a source of electrons such that two opposing-spin electrons have a reasonable probability of "falling into" the potential well of the nucleon (perhaps requiring another nearby particle to conserve energy and momentum). Sufficiently high density plasmas, either gaseous or metallic, might be expected to present these conditions. On the other hand, ionic materials, in which a pair of donor electrons are in close proximity to each other (such as might be found in a chemical bond) might similarly be advantageous to tresino formation. It would appear, however, that tresinos are not particularly easy to make. Their formation involves

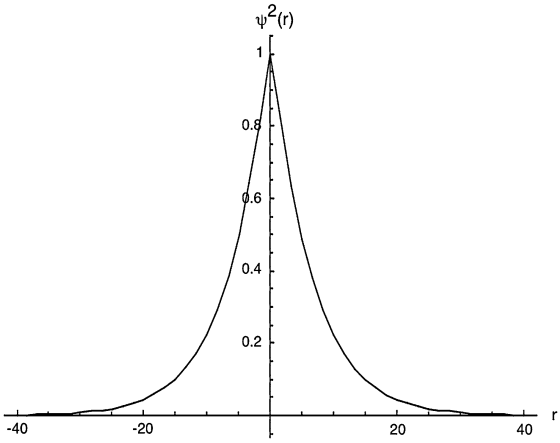

Fig. 2 Plot of $\psi^2(r)$ based on a simplified Schrödinger model

the interaction of three particles: protons (or deuterons or tritons) and two electrons, in a restricted geometry. A situation involving high densities of both protons and electrons would seem to be required for them to be produced.

Aside from being charged and thus responsive to an electric field, the tresino would appear to have little or no interaction with atomic systems. It would, therefore, stay around until being eventually destroyed or neutralized, very likely through attachment to a positive nucleon. The most likely nucleon is another hydrogen nucleus (p, d, or t) and, at least classically, it appears that this would be energetically favorable. The attachment would form either a tresino-proton pair (somewhat like a molecule) or what we will call a "quatrino".

A classical model of the quatrino is shown in Fig. 1(c). It is a four-body composite with two hydrogen nuclei located on the axis at $\pm z$ and two electrons on a circle of radius r in the midplane. The orbital velocity of the electrons is very small, and as before, and there is zero angular momentum (see Sect. 2). Using the same type of classical analysis used in Sect. 2, we find that $r = \sqrt{3}z = 0.211$, and the (classical) binding energy of the quatrino is about 25 keV. However, we admit that we do not have a quantum mechanical model of this complex composite.

Why haven't tresinos been seen? As already mentioned, they would not be readily created, they would not be reactive with electrons or atomic systems, and, although the h-tresinos are charged, they probably would not remain un-neutralized for very long. However, a tresino-proton pair (or a quatrino) being neutral, would be expected to move easily through macroscopic systems. The tresinos do not appear to have excited states therefore they would not have photon interactions other than possibly rotational or vibrational excitations.

Compton composite formation would release the binding energy for the h-tresino—3.7 keV from our Schrödinger solution. We speculate that this heat of formation may have been observed, but misinterpreted, in observations discussed in Sects. 5 and 7. In the 1990s there were many cases where this heat of formation may have been observed and measured, starting with the "cold fusion" experiments of Fleischmann and Pons [7]. Although usually these experiments involved deuterium-loaded Pd and/or ionic solutions containing deuterium ions, some cases [8, 9] used ordinary hydrogen in place of deuterium. The experimenters generally attributed the observation of the excess heat to nuclear reactions. But this interpretation has not been accepted by nuclear physicists. Still, the source of this excess heat, which is more than an order of magnitude larger than that from known chemical

reactions, has not been definitively identified. We propose that much of this heat (perhaps all of it in experiments using ordinary "light" water) comes from tresino formation energy. We present more discussion of these controversial observations in Sect. 7.

4 Compton Composites and Dark Matter

So far, we have been describing the characteristics and interactions of the h-tresinos which carry a net charge of minus one. Let us now consider the He-tresino. As with its atomic counterpart, the He-tresino is very strongly bound ($E_B = 14.3$ keV) and a neutral composite. This particle would be very small, neutral, and have a mass of about 3.7 GeV. It would be expected to have very few interactions of any kind with ordinary matter and would not be ionized except in the cores of very hot stars. As such, it might be a candidate for the so-called dark matter in the cosmological context.

The quatrino, if it exists, is also a neutral composite with a mass of 1.8 GeV. Here, we are considering the h-quatrino made of protons. This Compton composite should be stable and long-lived, and could also be a dark matter candidate. And yet another possibility for the dark matter: a combination of h-tresinos and protons in approximate charge balance, possibly bound together as proton-tresino molecules.

The He-tresino, the h-quatrino, and the tresino-proton pair, would be classified as weakly interacting massive particles (WIMPs). Interestingly, Peacock [10], notes that, "the universe may be closed by massive neutrino-like particles with masses around 3 GeV." But he also states "that none of the known neutrinos can be as massive as 3 GeV." The proton-tresino molecule (or the He-tresino) could have been formed in the early universe before the cooling and recombination of ordinary matter and might have continued to drift along with the universal expansion, being affected only by gravitational forces. These ideas are discussed more fully in a later paper.

5 Compton Composites and Heat from the Earth

For some time, it has been realized that there is a substantial discrepancy regarding the earth's internal heat source. That there is such a source is not in dispute, but the conventional explanation for the earth's internal heat (alpha decay of uranium and thorium) has an associated problem. Namely, where is all of the helium? At the elevated temperatures of the earth's interior, helium should readily escape. Therefore, measurements of the helium emanating from the earth would be expected to be in balance with the radioactive decay heat from these nuclides. Yet, this appears not to be the case. According to some measurements [11], there is approximately twenty times more heat than can be accounted for by the helium measured.

Perhaps tresino formation as mentioned above is possible in the high-temperature and pressure materials in the earth. There is also water in the earth's crust and mantle, and these conditions may favor the formation of Compton composites. If tresino formation energy is, in fact, the largest source of the earth's heat generation, it would explain why the major source of this heat comes from the crust and upper mantle, and it would also resolve a number of other unexplained anomalies concerning the earth's heat and helium emanations (Mayer and Reitz [12]).

6 Compton Composite-Induced Nuclear Reactions

As discussed in Sect. 3, the h-tresino in a hydrogen environment (p, d, t) will probably end up in the vicinity of hydrogen ions. Even if there is not permanent attachment to the ion, the electron shielding in the tresino will allow frequent nuclear encounters at a distance of a Compton or less. This opens up the possibility of nuclear reactions.

A tresino diffusing through a metal like Pd which has absorbed hydrogen (or deuterium) will be attracted to a hydrogen nucleon. At sub-coulomb barrier energies, neutron "stripping" (or transfer) reactions [13, 14] are the most common nuclear reactions. Tresino-induced neutron stripping may occur with a d-tresino operating in an environment containing other deuterons (more about these reactions can be found in [12]. The electrostatic force between the d-tresino and a deuteron favors bringing them into close proximity and with dynamic electron shielding the two nuclei may be brought to within a fraction of a Compton. Since the neutron in the deuteron is rather loosely bound and the energy for the reaction is favorable, the neutron may be picked up by the d-tresino (or, in some cases, the pick-up may be in the reverse direction) in the reaction $d + d^* \rightarrow p + t + 2e + 4\,\mathrm{MeV}$ where we use d^* to indicate the d-tresino and we might expect that the tresino breaks up in the process (however, see [12]). This type of neutron transfer reaction appears to be considerably more probable than *compound nucleus* formation requiring much closer encounters.

7 Compton Composites and "Cold Fusion"

The area known as "cold fusion" [15] has received much attention, both good and bad, over the past two decades. We will not attempt to explain all the claims or even all the experimental observations from this complex and muddled research area, but we will show that a number of otherwise unexplained observations are consistent with tresino induced reactions. A good overview of all of the anomalous results from this area can be found in a review paper by Storms [16, 17]. In addition, we note that there have been a number of models that have sought to find compact electron-proton systems to explain enhanced screening in "cold fusion" experiments. In particular, the work of Rice et al. [18] examined this issue and conclude that "models in which the electron is tightly bound to the hydrogen or deuterium nucleus were found to have serious qualitative or quantitative defects." In contrast to their work, the present paper requires two electrons interacting with a proton and has to include the electrons' dipole-dipole interaction. Hence, our Hamiltonian is quite different—one that yields the compact (and energetic) bound states presented above.

7.1 Observations of Excess Heat

The original papers by Fleishmann and Pons [7] introduced the cold fusion idea and claimed nuclear fusion as the source of "excess" heat in their electrochemical (deuterium-loaded Pd) cells. Although the heat was present, the expected energetic nuclear reaction products were not. These experiments were repeated by others, including some using non-deuterated water, many reporting "excess heat."

Now, if d-tresinos are formed during deuteron loading of palladium, there are at least two possibilities to generate heat. First, there is the binding energy of the tresino which is released during its formation ($\approx 2 \times 10^8$ joules/gram). Second, there is the much larger energy per reaction if neutron transfer reactions take place. There may have been many instances in which the heat of tresino formation has been observed but misinterpreted as chemical reaction heat.

7.2 Observations of Tritium

For many years, there have been observations of tritium being produced in deuterium loaded metal experiments [19, 20]. These observations were not accompanied by other nuclear reaction products such as neutrons which might have been expected from ordinary $d - d$ fusion reactions because the neutron and triton branches, through compound nucleus formation, are about equally probable. Although the tritium was many orders of magnitude above background, extensive measurements were made to eliminate the possibility of tritium being somehow introduced into the experiment as an impurity. These experiments may be explained as the result of the tresino-induced neutron transfer reactions in deuterated material (see previous section).

Many (but not all) of the controversial claims and observations of this experimental area may have straightforward explanations through the heats of formation of tresinos and quatrinos or through nuclear reactions in which they play a role. This possibility will be the focus of a future paper.

8 Discussion

We have proposed the existence of a new class of subatomic, composite particles which might have eluded direct observation. Although we are unable to present a formal quantum electrodynamical solution for the Compton composite particles, we have shown that their existence is not in conflict with well-established quantum mechanical principles.

But perhaps more interesting is the indirect evidence. The existence of these particles can provide explanations for a number of physical observations which have so far eluded attempts at explanation. These include (1) the discrepancy between the heat emanating from the earth and its proposed source from radioactive material, (2) the unexplained excess heat generated in "cold fusion" experiments, and (3) the composition of the dark matter filling the universe. Perhaps most telling is the thermal emanations from the earth: not only is the heat evolved about twenty times larger than its "supposed source" from radioactive material, based upon the amount of helium emitted, but this helium also contains ^{3}He (not a component of radioactive decay from U and Th). Furthermore, there is evidence that at least some of the large scale magma deposits had their origin in surface-derived material, not from deep in the mantle. Thermal energy generation in the earth is discussed in a later paper [12].

Finally, we mention that if our tresino picture applied to dark matter is correct [21], it shows that the dark matter—the material filling most of the universe—is composed of well-known entities—electrons and hydrogen nuclei.

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Comment from the PCAST Website

05/30/2012 - 2:15am
jerry A. Myers
[redacted]

IT is very obvious that the White House will not address the easy access to the most sensitive atomic/Nuclear research data.This will not be discussed because the President science and technology team can care-or-less about Nuke saftey or Atomic Security.

Comment from the PCAST Website
05/30/2012 - 6:27pm
Anis Rahman
[redacted]

Dear PCAST:

I am an inventor and an entrepreneur, developing new technology for security and surveillance. Attached please find a brief brochure of the imaging product that allows to see hidden weapon. Also, more dexription of products are on the web: http://arphotonics.net

However, we face tremendous difficulty to raise funds for commercializing these products. I shall be thankful if PCAST has any suggestions for our specific situation.

Sincerely,

Anis Rahman

[redacted]

Terahertz imaging system: TeraImager©

Introduction

The system is composed of three main components.

1. A terahertz source suitable for generating wide range terahertz radiation for illuminating the object interior
2. A camera system for capturing image on the surface and sub-surface
3. A computer with software for capturing and analyzing the images

Each of three components are described below.

1. Terahertz source

Applied Research & Photonics (ARP) uses its CW terahertz source for imaging applications. The source is a wide range broadband covering from ~0.1 THz to ~35 THz. Two T-ray sources were tested for both reflection and transmission imaging. A FLIR camera was used for testing of reflection imaging over a distance of ~10 ft. Example of imaging by this source with an in-house imaging demo is shown in Fig. 1–4. A metallic object hidden behind different fabric and cardboard was used for imaging demo. Normally, the object is not visible by the camera either in reflection or in transmission. But when the terahertz source is shined on it, the object becomes visible. This is because the T-ray penetrate the hiding layers but is reflected back by the metallic object, allowing imaging in reflection. In transmission, the T-ray is stopped by the object but transmitted through the packaging materials, thus the image of its shape is formed.

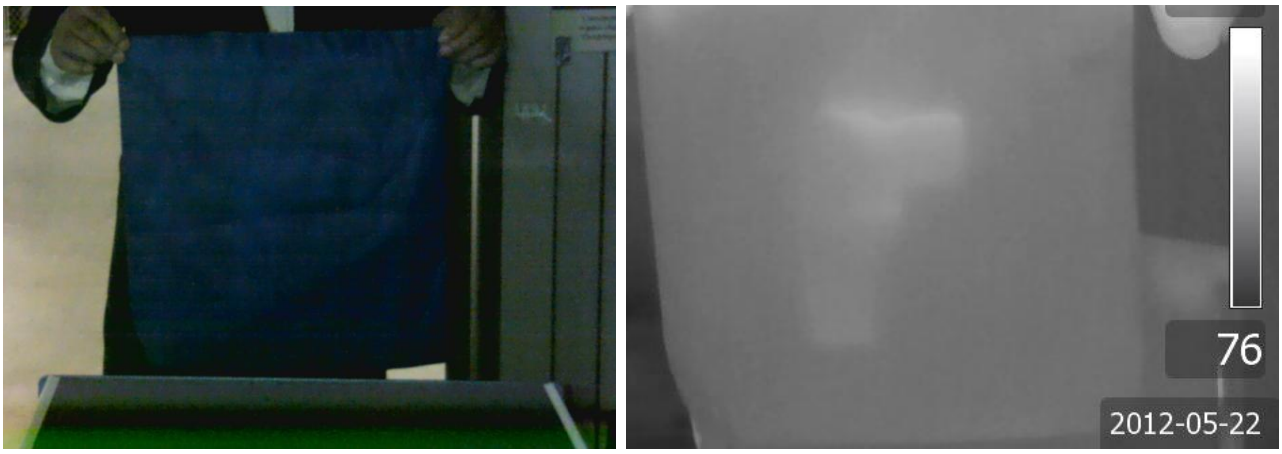

Fig. 1. A hidden metallic shape inside a bag (left) revealed with T-ray (right). Picture taken in reflection from ~10 feet away by FLIR camera. The T-ray source is a dendrimer based fixed power source ~10 mW, CW.

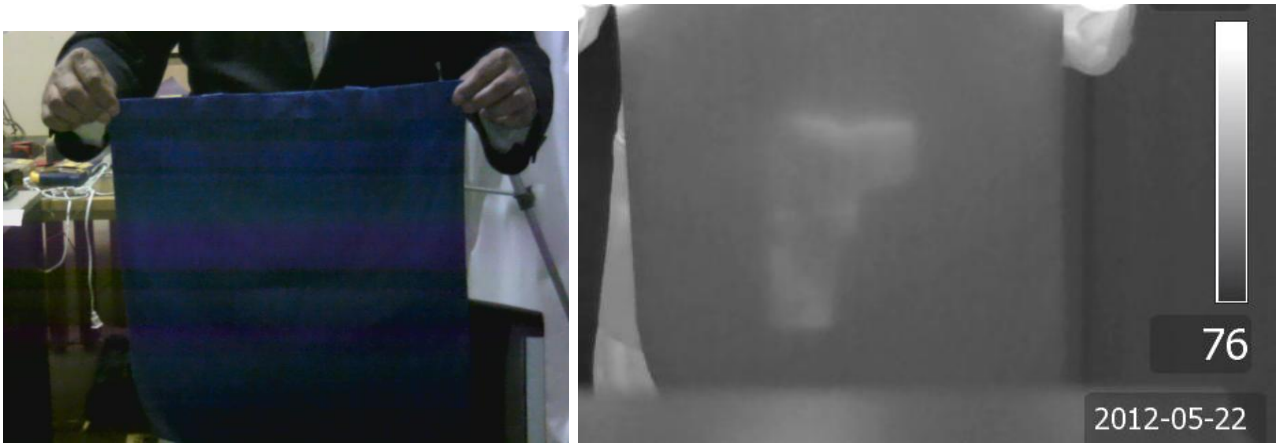

Fig. 2. The same hidden metallic shape as above inside a bag (left) revealed with T-ray (right). Picture taken in reflection from ~10 feet away by FLIR camera. The T-ray source is a dendrimer based tunable source pumped by fiber-coupled CW laser.

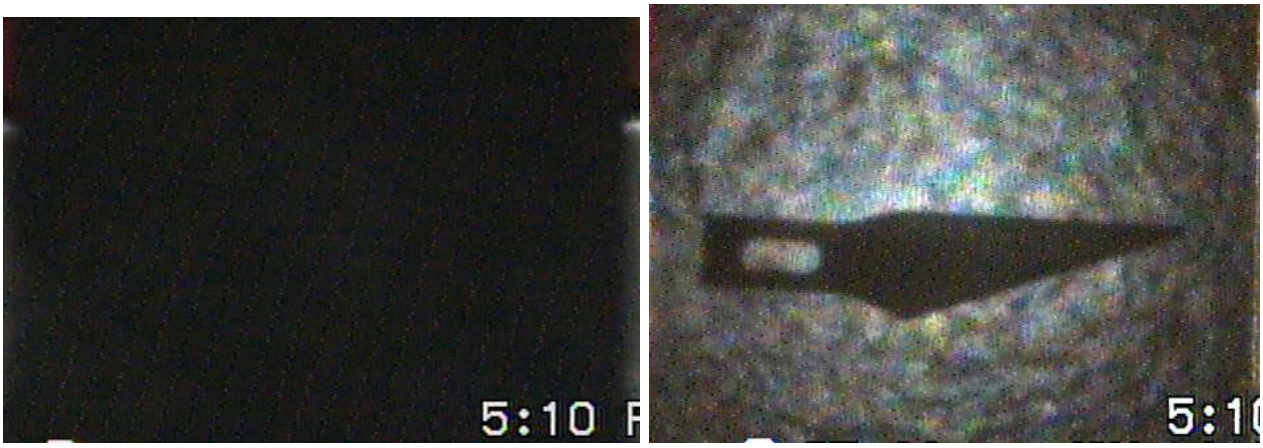

Fig. 3. A hidden blade behind a cardboard is revealed with the terahertz source. Picture was taken in transmission. Field of view is ~6" x 6" with distance between the camera and object ~1 ft.

Fig. 4. (Contd.) A metallic knife hidden behind a thick dark cloth is revealed by the terahertz beam. Picture was taken in transmission.

2. Terahertz Camera System

The terahertz camera system has been developed by FLIR Systems (Nashua, NH 03063, USA) for surface imaging. The camera is being tested for detection of concealed weapons in conjunction with the terahertz source described above. This system will be mounted on a vehicle for remote monitoring and screening applications. Fig. 5 shows a concept picture of the camera. As shown on the right, the camera housing may accommodate two cameras; one terahertz camera for hidden gun detection and one regular camera for other objects.

With ARP's terahertz source, it will be able to make terahertz imaging of concealed weapons, etc.

The field of view and the standoff distance may be adjusted by using a single or multiple sources. For a single source and for reflection imaging, the coverage area is ~ 1 sq. ft. at a distance ~10 ft. For transmission, the working distance is ~ 1 ft. with the field of view is ~ 6 sq. inch.

2.1. Special Features[1]

The terahertz camera has a number of useful features suitable for remote surveillance:

- 640 x 480 pixel IR resolution
- Fully programmable scan patterns, radar slew-to-cue, and slew-to-alarm functionality
- Built-in spot and area temperature measurement analysis functionality
- Extensive alarm functionality, controllable by the operator
- h.264, MPEG-4, and MJPEG streaming
- 100MB Ethernet supplies simultaneous analog and digital video at 30 Hz
- IP control: Integrate with any existing TCP/IP network and control over a PC.
- Multi-camera software: FLIR Sensors Manager allows users to manage and control a PT-Series camera in a TCP/IP network

[1] Specifications may change

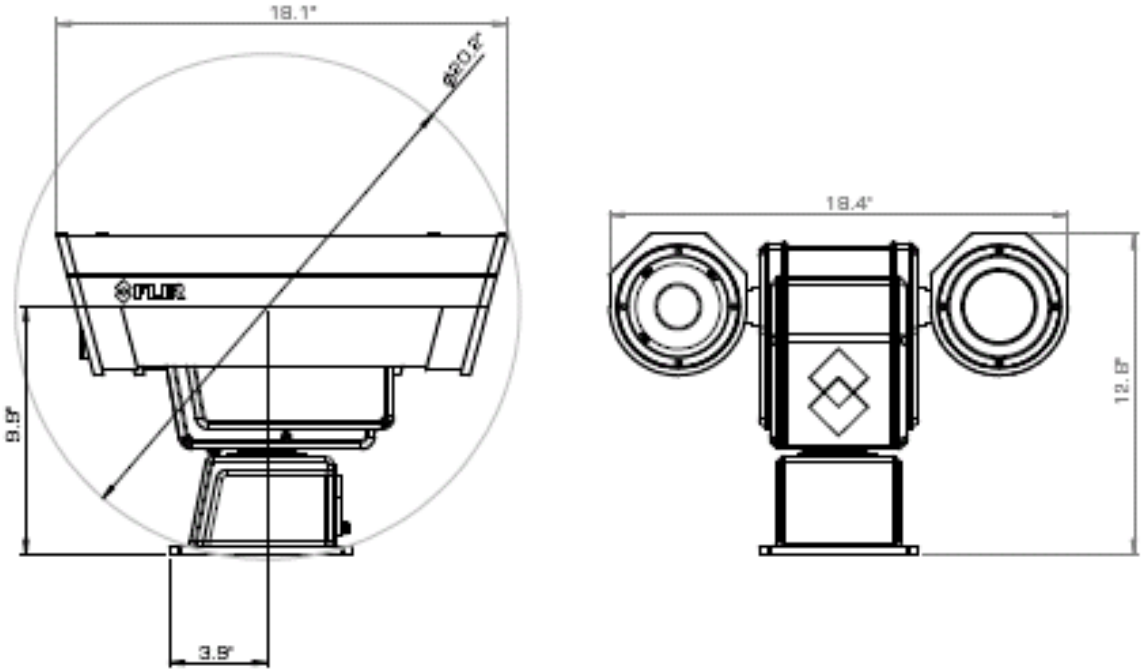

Fig. 5. Top: Camera housing for a single or double camera system. Bottom: Drawing of the camera housing for vehicle mounting.

3. Software

The software will be included as a utility CD or preinstalled on a computer.

Key Features of the software

- Setup of alarms and I/O configuration for digital out

- Setting of scheduled events and other e-mail options
- Setup and visualization of up to nine cameras for stand-alone applications, e.g., on-line monitoring and control
- Setup of synchronized signals for recording of image sequences in FLIR ResearchIR
- Draw a mask to cut out part of the image not to be analyzed
- Saving of images and image control

4. Pricing and delivery

ARP is taking order from the early adapters. The system will take approximately 6–8 weeks for delivery.

4. Contact

For further information and placing order, please contact:

[redacted]

Comment from the PCAST Website

06/03/2012 - 4:41am
jerry a. Myers

[redacted]

When did easy access to very sensitve atomic research data considered an non issue by this White House.Will the PCAST ever address this as an issue.
http://home.comcast.net/~jerrymyers5005

From: "Beau Backus" [redacted]
Subject: May 25, 2012 President's Council of Advisors on Science and Technology (PCAST) Webcast Question
Date: Mon, June 4, 2012 12:56 pm
To: pcast@ostp.gov

Should we continue to have Federal only spectrum and for what purpose?

Federal spectrum use is typically focused on meeting mandated Federal missions or activities - to what level of risk can we let such missions such as meteorological operate?

06/04/2012 - 2:26am
jerry a. Myers
[redacted]
[redacted]

IF is very obvious that the PCAST will avoid certain comments.IF the White House science and technology staff tnink ignoring the easy exposure of very sensitive atomic/Nuclear research data is an non-issue,then abandon security.This put the world at risk.

From: "Don Balka" [redacted]
Subject: RE: TODOS Response to PCAST Report
Date: Wed, June 6, 2012 11:41 am
To: PCAst@ostp.gov

Attached is a response to the PCAST Report of February 2012 from TODOS: Mathematics for All.

Dr. Don S. Balka
President
TODOS: Mathematics for All

Professor Emeritus
Saint Mary's College
[redacted]

Attachments:

TODOS PCAST RESPONSE 612.doc	
Size:	279 k
Type:	application/msword

Central Office

Executive Co-Directors
Julie Thomas & Juliana Utley
Oklahoma State University
College of Education
Phone: [redacted]
Fax:
E-Mail:
[redacted]

School Science & Mathematics Association

June 6, 2012

John P. Holdren
Eric Lander
President's Council of Advisors on Science and Technology
White House
Washington, DC

Response to the PCAST Report to the President, *Engage to Excel*

Dear Dr. Holdren and Dr. Lander,

TODOS: Mathematics for All is a national organization that advocates for an equitable and high quality mathematics education for all students — in particular, Hispanic/Latino students — by increasing the equity awareness of educators and their ability to foster students' proficiency in rigorous and coherent mathematics. We are an affiliate of the National Council of Teachers of Mathematics, and will celebrate our 10th anniversary next year.

Many points in the PCAST report are relevant to the mission and goals of TODOS. We applaud the efforts of the Council in including issues of equity as we move forward in STEM education. TODOS members, who are well-known authorities in the field, wrote many of the equity research papers cited in the report. The emphasis on STEM courses, particularly in mathematics, in the first two years of college is very important because community colleges are the most common entry points for minority students to access postsecondary education. We understand the lack of role models for women and ethnic minorities in STEM fields, and encourage the Council to pursue this issue strongly.

The PCAST report also discusses the glaring lack of underrepresented students in STEM subjects. We encourage the Council's pursuit of funds for these students and its focus on minority-serving institutions as outlined in the report.

We look forward to working with the Presidential Council on future STEM items related to underrepresented students.

Thank you.

Don S. Balka
TODOS President
Professor Emeritus
Saint Mary's College
[redacted]

From: "Don Balka" [redacted]
Subject: Re: SSMA Response to PCAST Report
Date: Wed, June 6, 2012 10:40 am
To: pcast@ostp.gov

Attached is a response to the PCAST Report of February 2012 from
School Science and Mathematics Association.

Dr. Don S. Balka
President
School Science and Mathematics Association

Professor Emeritus
Saint Mary's College
[redacted]

Attachments:

SSMA PCAST RESPONSE 612.doc	
Size:	264 k
Type:	application/msword

Central Office

Executive Co-Directors
Julie Thomas & Juliana Utley
Oklahoma State University
College of Education
[redacted]

[redacted]

School Science & Mathematics Association

June 6, 2012

John P. Holdren
Eric Lander
President's Council of Advisors on Science and Technology
White House
Washington, DC

Response to the PCAST Report to the President, *Engage to Excel*

Dear Dr. Holdren and Dr. Lander,

School Science and Mathematics Association, the nation's oldest professional organization for mathematics and science educators, supports the fundamental message of the February 2012 report from the President's Council of Advisors on Science and Technology, *Engage to Excel: Producing one million additional college graduates with degrees in Science, Technology, Engineering, and Mathematics.*

As an organization that has been promoting STEM education since 1901, long before STEM reached the high point it now has obtained, SSMA focuses on promoting research-based innovations related to K-16 teacher preparation and continued professional enhancement in science and mathematics.

The PCAST report discusses the growing body of evidence for the effectiveness of using class time to actively engage students in thinking about the concepts they are learning. Authors of research articles in the *School Science and Mathematics Journal*, have reported on this aspect of engagement for our STEM fields for several years.

We look forward to working with the Presidential Council on future STEM items of interest.

Thank you.

Don S. Balka
SSMA President
Professor Emeritus
Saint Mary's College
[redacted]

Comment from the PCAST Website

06/08/2012 - 10:49pm
Marilyn E. Strutchens
Association of Mathematics Teacher Education
[redacted]

Please see the attached response to the February 2012 PCAST Report

Association of Mathematics Teacher Educators

June 8, 2012

John P. Holdren
Eric Lander
President's Council of Advisors on Science and Technology
White House
Washington, DC
Response to the PCAST Report to the President, Engage to Excel

Dear Dr. Holdren and Dr. Lander:

The Association of Mathematics Teacher Educators (AMTE) strongly supports the essential message of the February 2012 report from the President's Council of Advisors on Science and Technology, *Engage to Excel: Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering, and Mathematics*. We particularly applaud the goals to improve the teaching and learning environments of undergraduate mathematics, agreeing that the "STEM courses during the first two years of college have an enormous effect on the knowledge, skills, and attitudes of future K-12 teachers" (PCAST Executive Summary, p. 2). We further support PCAST's earlier report on K-12 STEM education, "*Prepare and Inspire: K-12 Science, Technology, Engineering, and Math (STEM) Education for America's Future,"* which calls for the federal government to establish the objective of recruiting, preparing, and providing induction support for at least 100,000 new STEM middle- and high-school teachers who have majors in STEM fields and strong content-specific pedagogical preparation.

AMTE is the largest professional organization devoted to the improvement of mathematics teacher education, with approximately 900 members devoted to the preservice education and professional development of K-12 teachers of mathematics. The mission of AMTE is to promote the improvement of mathematics teacher education, K-*12.*The goals of AMTE are to promote: 1) effective mathematics teacher education programs and practices; 2) communication and collaboration among those involved in mathematics teacher education; 3) research and other scholarly endeavors related to mathematics teacher education; 4) professional growth of mathematics teacher educators; 5) effective policies and practices related to mathematics teacher education at all levels; and 6) equitable practices in mathematics teacher education, including increasing the diversity of mathematics teachers and teacher educators. Mathematics teacher educators include mathematics educators, mathematicians, general educators, teachers, educational psychologists, family members, and others who share this mission.

AMTE can serve as a vital partner in attaining recommendation (3) of the current report and in meeting some of the PCAST report's STEM education goals. We have a history of bringing mathematics teacher educators together to address issues of importance to the field. Recently AMTE, with support from The Brookhill Foundation, published the *Standards for Elementary Mathematics Specialists: A Reference for Teacher Credentialing and Degree Programs* (AMTE, 2010). The team that wrote the document included both mathematicians and mathematics educators. AMTE's publication of this document and its supporting conferences have encouraged 11 states to create elementary mathematics specialist state certifications with certification guidelines in progress in several other states. This movement will continue to help increase the mathematical pedagogical and content knowledge of elementary teachers, provide administrative support and professional development for elementary teachers, and increase elementary students' mathematics achievement.

In addition, through the Mathematics Common Core Coalition (mathccc.org) AMTE is working with other organizations to support teachers in the implementation of the Common Core State Standards, which 45 states have adopted, with the intent to increase students' potential for being college- and career-ready upon graduation from high school. AMTE also has a task force whose charge is to help mathematics teacher educators as they work with teachers implementing these goals.

Many of our members are also engaged in the revision of the *Mathematics Education of Teachers* report (Conference Board of Mathematical Sciences) to be released later this year and in the Mathematics Teacher Education Partnership sponsored by the Association of Public and Land Grant Universities/Science Mathematics Teacher Imperative. Both of these initiatives involve mathematicians, mathematics educators, and school personnel who are working together to improve the preparation of teachers, which includes the revision of many of the STEM-related content courses taught in teacher candidates' programs and other aspects of teacher preparation.

As you can see, AMTE, working with other mathematics education organizations, has begun to make strides toward addressing the report's recommendations. As consideration is given to the creation of the Presidential Council on STEM Education, I strongly encourage you to consider formally including the voice of mathematics teacher educators by naming a representative of AMTE to the council. AMTE's perspective is integral to the success of realizing the report's recommendations.

Thank you for your considerable efforts in producing this report, which provides strategic recommendations for addressing increasingly pressing education and workforce issues. Please let me know how I or AMTE can further support your work.

Sincerely,

Marilyn Strutchens

Marilyn Strutchens
President, Association of Mathematics Teacher Educators
Mildred Cheshire Fraley Distinguished Professor of Mathematics Education
Auburn University

From: "SCOTT GOMPERT" [redacted]
Subject: Engage to Excel report, February 2012
Date: Sun, June 17, 2012 11:49 am
To: pcast@ostp.gov

Hello,

I am a student at Arizona State University working on my certification to be a high school physics teacher and I read your report to the President on STEM college graduates with great interest. I wholeheartedly support the findings and analysis in this report, however, did PCAST consider the very large population of STEM workers who do not have 4-year degrees? I know your report talks about increasing qualified high school STEM teachers and I count myself as one of your targeted improvements. However, I frequently sense the focus of everyone's efforts is solely on producing more college graduates and I am left asking - What about the +50% of high school students who do not go on to college?

Intel Corporation has a very large presence in our community here and it is my general understanding they employ a large number of people in manufacturing who do not have 4-year university degrees. Many of these workers receive significant on-the-job training, but they must all bring a basic level of sophistication to their jobs that they mostly pick up in high school.

I hope to be teaching in a Title 1 dominated high school by the Fall of 2013 and know the majority of my students will not be going to college. I firmly believe these non-university bound students can still participate/prosper in our economy as scientifically literate citizens whether that includes a job in hi-tech industry or not. In my community, 1/3 of our Hispanic students drop out of high school because they see no relevance and no hope in continuing their education. They need EOP's attention as much as the STEM college undergraduates.

I searched PCAST's website and could not find any work that significantly addresses the non-college bound students that still make up more than 50% of our high school population. Please advise me if I have missed a report or study from your body of excellent work that you feel touches on the subject I raise here.

Thank You,
Scott Gompert
Graduate Student,
Mary Lou Fulton Teachers College,
Arizona State University

Attachments:

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Comment from the PCAST Website
06/18/2012 - 11:41pm
jerry a. Myers
[redacted]
[redacted]

I am very well aware of the White House staff
ignoring most comments.This one will be ignored as well.But my point will be heard
despite avoiding the issue.If the White
House think it is an non-issue to not discuss
the sensitive Nuclear/Atomic data,then I give
up.It is too sad to find out that the U.S.
Government can-care-or-less about easy access
to Nuke communications the DOE,NRC and the
NNSA know little about.

Comment from the PCAST Website

06/19/2012 - 7:34am
Adam Sobieski
[redacted]

Office of Science and Technology Policy,

Executive Office of the President,

Greetings. The IdeaScale website for PCAST, http://pcast.ideascale.com/, appears to be somewhat stale with content from before September of last year. I wanted to comment about that website-related observation and to inquire into whether any other or more online venues or means of interaction exist for transparency, public participation and collaboration with OSTP and PCAST.

Thank you,

Adam Sobieski

AMS
AMERICAN MATHEMATICAL SOCIETY

[redacted]

Eric M. Friedlander, President
[redacted]

June 21, 2012
Via email and postal mail

Professor S. James Gates, Jr.
John S. Toll Professor of Physics
Director of the Center for String and Particle Theory
[redacted]

Dear Jim:

Attached to this letter is a statement made on behalf of the American Mathematical Society and approved by its leadership.

We express the interest, concern, and involvement of the mathematical community both in the quality of STEM education and in the challenge of producing more STEM graduates. We emphasize that innovation and experimentation in college-level mathematics teaching is undertaken by mathematicians throughout the nation. We also point out that mathematicians seek the input and collaborative effort of other STEM scientists in the teaching of mathematics.

Finally as stated in the attached statement, we emphasize that "mathematicians [must] be actively engaged in the planning and teaching of the mathematics courses that form the foundation of STEM education." We affirm that "the mathematical community welcomes the challenge of joining with our STEM colleagues to develop new approaches to enhance the learning experiences of those many students who aim for careers requiring a sound STEM education."

Sincerely yours,

Eric M. Friedlander

EMF:sjr

Attachment

MATHEMATICIANS' CENTRAL ROLE IN EDUCATING THE STEM WORKFORCE

ERIC M. FRIEDLANDER, PRESIDENT OF THE AMS,
TARA S. HOLM, CHAIR OF THE AMS COMMITTEE ON EDUCATION,
JOHN EWING, REBECCA GOLDIN, WILLIAM H. JACO, T. CHRISTINE STEVENS,
ABIGAIL THOMPSON, AND DAVID VOGAN

Mathematicians strongly support President Obama's goal of increasing the number of college graduates with STEM training. We promote high quality undergraduate mathematics education not only to increase numbers of STEM graduates but also to assure that these graduates have the education and perspective to succeed in an evolving, increasingly technological world. In active collaboration with our STEM colleagues, we shall continue to explore enhancements to entry-level college mathematics curricula to serve STEM students.

In response to the recent PCAST report *Engage to Excel*[1] the mathematics community recognizes the need to publicize its commitment to developing quality entry-level college education. One of our fundamental goals is to broaden the spectrum of students successfully prepared for STEM careers. In order to achieve this goal, we must enable an increasingly diverse cohort of students to acquire core mathematical concepts and basic mathematical reasoning. A solid foundation in mathematics is essential for successful STEM education, for this paves the way for flexibility in a changing workforce environment.

Some of the specific comments and recommendations in the PCAST report have caused alarm and consternation in the mathematics community. In particular, we strongly object to the recommendations for teaching and course development of college level mathematics *"by faculty from mathematics-intensive disciplines other than mathematics*" and "a new pathway for producing K–12 mathematics teachers from ... *programs in mathematics-intensive fields other than mathematics."*[2] We firmly assert that **it is essential that mathematicians be actively engaged in the planning and teaching of the mathematics courses that form the foundation of STEM education.** Mathematicians' understanding of the common mathematical themes that arise in applications across STEM disciplines place them at the center of STEM education. Mathematicians guide students to explore their ideas using skills which will apply beyond immediate problems; we facilitate students' efforts to understand the principles and logic that underpin applications. A mathematician's primary training is to think effectively about quantitative problems, and we are dedicated to communicating our understanding to our students.

[1] Available at http://www.whitehouse.gov/administration/eop/ostp/pcast/docsreports.
[2] *Ibid.*, p. 30. Italics added for emphasis.

Mathematicians are eager to continue their partnership with other STEM colleagues to adapt mathematics curricula and pedagogy. In this way, mathematicians are constructive partners in translating basic mathematical concepts and reasoning to science and engineering. We seek to enhance the ability of all STEM students to apply quantitative and critical thinking skills from mathematics to other disciplines. In order to achieve the President's goal of greatly increasing the number of well-prepared STEM graduates, heightened efforts need to be made to adjust the curricula of mathematics courses for STEM students so that the material effectively reflects the mathematics that arises in STEM fields. Mathematicians support efforts by the Department of Education and the National Science Foundation to achieve pedagogical and curricular reform through funding of collaborations between mathematicians and other STEM scientists.

The mathematics community embraces experimentation in teaching methods, technology for the augmentation of learning, and adaptation of curricula. Such efforts need to be carefully assessed, with care taken in defining and interpreting assessment metrics. Mathematicians recognize that there is not just "one problem" to solve, that promoting knowledge of basic mathematics and a facility with its use requires dramatic improvements in pre-college mathematics education and an encouragement of problem-solving talents. No single pedagogical method will be suitable for every classroom, no curriculum is appropriate for all students. Success in education is not achieved by simple formulas: there are many different successful ways of teaching mathematics, techniques adapted to the variation of talents of both students and teachers.

We call attention to the many efforts to meet the challenges of teaching entry-level college mathematics. The American Mathematical Society (AMS) has established a website[3], which is beginning to collect a listing of some of these efforts, others have been recognized by special awards[4], and others are discussed in various reports[5]. Although experimentation, innovation, and implementation of pedagogical methods typically occur at the local level, the insights gained from local efforts can be disseminated nationally by the AMS and other national organizations. The AMS can also play an important role in encouraging cooperation between mathematicians and researchers in mathematical education.

Our society requires many more young people who are well trained and confident in their use of quantitative and technological methods. In order to reach as many students as possible, education in entry-level college mathematics must continue to evolve. No easy answers are available, but the mathematical community welcomes the challenge of joining with our STEM colleagues to develop new approaches to enhance the learning experiences of those many students who aim for careers requiring a sound STEM education. This challenge requires sustained commitments of time and resources from mathematicians, faculty from other STEM disciplines, granting agencies, colleges, and universities.

[3]See http://www.ams.org/programs/edu-support/teaching-innovations.

[4]See http://www.ams.org/profession/prizes-awards/prizes.

[5]For example, the AMS report, *Towards Excellence*, is available at http://www.ams.org/profession/leaders/workshops/towardsexcellence.