

The BIG Notebook

A Newsletter of the MAA Special Interest Group for Mathematics in Business, Industry & Government

My Mathematical Path So Far

by Tegan Webster

Rensselaer Polytechnic Institute

Entering college, I knew that I was interested in studying math and getting involved in undergraduate research, but I had little idea what math or research would be like at the college level. My experiences, like most of my peers, consisted of high school math classes with year-long topics and science fair projects presented on trifold poster board. I was excited but overwhelmed by the variety of topics that were taught in the mathematics department and I had no idea how to get involved in undergraduate research.

I was lucky; towards the end of my first semester I heard that a professor in my department was looking for undergraduate math and biology students to work together on joint math and biology problems. That next semester I had the opportunity to work in a small group with other undergraduates to model biological chain evolution of *E. coli*. This was the first research experience for all of us in the group; we experienced both the difficulty of coming up to speed on a new topic and the frustration of working as part of a team, dividing work and combining efforts. Still, we managed to work together and presented our efforts at the Hudson River Undergraduate Mathematics Conference where we met other undergraduate students working on a huge variety of mathematical problems. This first research experience

(Continued on Page 2)



Tegan Webster

Inside:

- * Freedom Versus Security: A Quandary for Universities, by Margaret Cheney, Colorado State University
- * BIG SIGMAA events at the Joint Mathematics Meetings in San Diego
- * Mario Livio is the BIG SIGMAA Invited Speaker at JMM in San Diego
- * Fixed Points, a poem by Susan Case
- * Quotation Corner
- * New Artworks by Collin Carbno

rience led me to apply that summer for a program at my college that allowed me to take graduate courses and to begin research with a graduate advisor while still an undergraduate.

As a participant of the program, I was encouraged to learn more about the research being done by professors in my department. But I was still unsure whether to stay at my undergraduate institution for graduate studies. I spoke with several professors and began working with Professor Margaret Cheney, formally of the Center for Inverse Problems at Rensselaer Polytechnic Institute's Department of Mathematical Sciences. I took independent study courses with other members of the research group and gradually began to learn more about radar imaging and electromagnetic wave propagation. That following year I completed my senior thesis in unmanned aerial vehicle flight path planning to ensure effective radar surveillance. I found this area of research to be a great fit and I was fortunate to be able to continue working with the same professor and fellow research students, while pursuing my masters and doctorate degrees."

While a graduate student I was able to spend one summer at MIT Lincoln Laboratory working as a summer researcher. I learned about the mathematical fundamentals of radar tracking and had the opportunity to work with real tracking data. More importantly, attending seminars and talking with other employees exposed me to the other work being done at the lab, including many areas of research that had mathematical components.

Two years ago I became a participant of the student career experience program at the Radar Division of the Naval Research Laboratory in Washington, DC. During my time at NRL I have been able to develop theory for scalar and vector multi-static radar data modeling and imaging of moving targets, the focus of my dissertation

Editor's Note

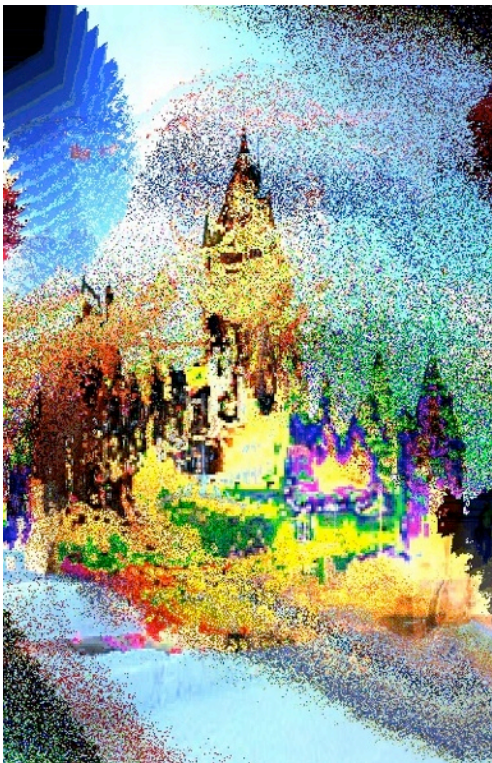
We are fortunate to have a contribution in this issue from Margaret Cheney highlighting a dilemma many universities are facing. Their choice is between guaranteeing the same degree of access to university activities for all students (including international students), or whether to allow activities that only a subset of students can participate in. The cost for taking the path of openness can be the loss of millions of dollars in military-funded research, and the loss of faculty and staff, since such research can exclude foreign students or others who may not be able to work with sensitive or classified materials.

The profile piece for this issue comes from Tegan Webster, one of Margaret Cheney's graduate students. Her path to promising research in applied mathematics reveals some of the many opportunities available these days to students of Mathematics.

The poem "Fixed Points" is from [The Scottish Café](#) ([Slapering Hol Press](#), 2002), by [Susan Case](#). The poem imagines the beginnings of a watering hole (named "The Scottish Café") for a community of mathematicians in Lvov Poland (now in Ukraine) in the years just before, and during, World War II. Some of the mathematicians in the group would go on to make major advances in Mathematics; others would perish in the war. In this sense, Case's collection of poems captures a fascinating moment in time. "Fixed Points" refers to a book named *The Scottish Book*, maintained by the group and kept at the café, in which problems were posed and solutions entered.

work. I have also been able to contribute to other research efforts at the lab by applying my training as an applied mathematician and I have found that radar modeling and signal processing are areas of research that benefit from collaboration of individuals with a variety of backgrounds and training. At the lab I have also learned about and worked with experimental radar test equipment that I would never have access to in my math department.

I am very early in my career but I have already seen that there are many areas of research that have a place for mathematicians. My experiences working in research laboratories while still a graduate student have been extremely beneficial and I would suggest that other students take advantage of internships or co-op programs to gain experience while pursuing their degrees.



Mathematical Kingdom, by Collin Carbno

Mario Livio is the BIG SIGMAA Invited Speaker at JMM San Diego, January 2013

by Carla Martin

We invite you to attend our guest lecture and reception the evening of January 11. Dr. Mario Livio, Space Telescope Science Institute, will give the guest lecture. The title of his talk is "Is God A Mathematician?" The talk will span such fields as mathematics, cosmology, physics, and the cognitive sciences, and will attempt to offer an accessible and lively account of the ideas of some of the greatest mathematicians and scientists in history, from Archimedes to Galileo and Descartes, and from Newton to Hilbert and Gödel, on up to the present day. It will be a talk not to miss.

Quotation Corner

The union of the mathematician with the poet, fervor with measure, passion with correctness, this surely is the ideal.

-- William James (*Collected Essays*)

It is clear that Economics, if it is to be a science at all, must be a mathematical science.

-- William Stanley Jevons (*Theory of Political Economy*)

The mathematician may be compared to a designer of garments, who is utterly oblivious of the creatures whom his garments may fit. To be sure, his art originated in the necessity for clothing such creatures, but this was long ago; to this day a shape will occasionally appear which will fit into the garment as if the garment had been made for it.

-- George Dantzig

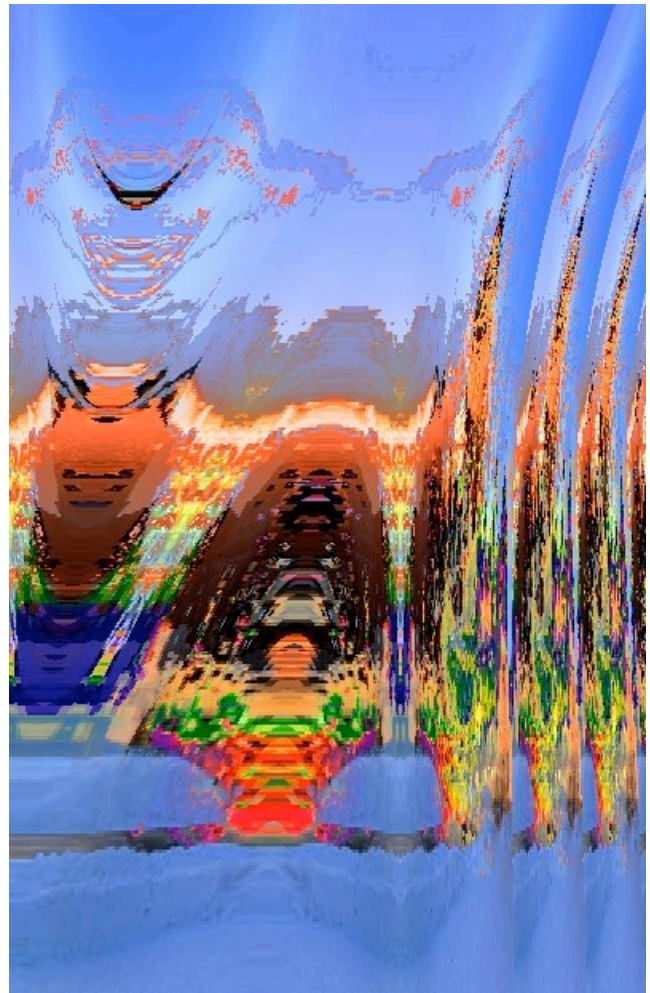
Fixed Points

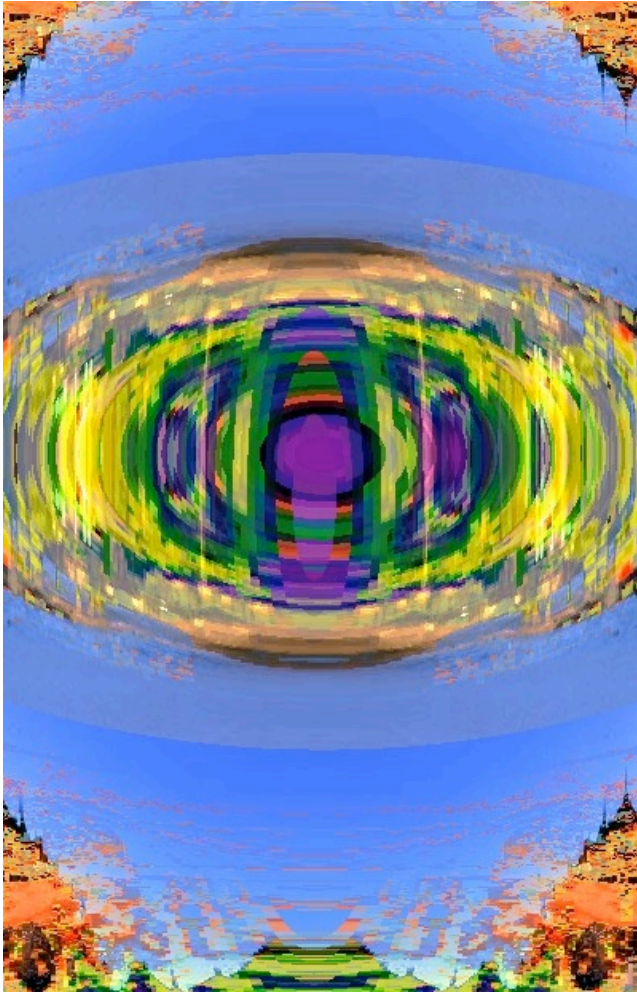
by Susan H. Case

At first they meet at the Café Roma in Lvov
 on Saturday nights to discuss mathematics
 and drink cognac
 but Banach lives beyond his means
 and is annoyed that he can't work out something
 with the proprietor about his debt
 so he persuades the others to move
 across the street
 to Zielinski's place--the Scottish Café
 where the food is not as good
 the cognac is not is good
 but the music is good
 and the credit is better
 and they begin to meet each day around five
 Banach -- Mazur -- always the center
 at a little table with a marble top
 where they talk and write
 and stare silently at the spaces in their minds
 filled with even more formulas
 than those written down on the marble table top
 some of which later get written down
 in a school notebook with a marble-pattern
 cardboard cover
 that Banach's adored wife Lucja
 buys for two-and-a-half zlotys
 at a drugstore in Lvov and into which Banach
 who does not like to write things down
 enters the first problem in nineteen-thirty-five

 problems go on odd pages
 solutions on the opposite pages
 filling up the Scottish Book -- it is chaos some-
 times --
 arguing and writing and thinking
 but chaos is better than order -- says Auerbach --
 you can't lose anything in chaos
 (or find anything either)
 but a lot of mathematics
 is found
 at the Scottish Café

and lost too -- one session lasts seventeen hours
 and results in a proof of a theorem
 about Banach spaces
 but no one writes it on paper
 only on the table top
 which is wiped off later by the janitor
 after the Café shuts for the night
 which still today no one can reproduce

**Ripples in Time and Space, by Collin Carbno**



Eye of Mathematics, by Collin Carbno

Editor: Greg Coxson
 Copy Editing: Allen Butler
 Artist: Collin Carbno
 Poetry advisor: JoAnne Grownney
 Quotations archivist: Bill Haloupek

Freedom Versus Security: A Quandary for Universities

by Margaret Cheney, Colorado State University

Approval

Hurray! Two faculty collaborators, Megan and Barbara, learned that they had just won their first STTR (Small Business Technology Transfer) contract. Their networking was finally paying off! Maybe this small Phase 1 contract would lead to a larger Phase 2 one, and that, in turn, would lead to better connections with industry, which in turn would give them future contracts.

Megan and Barbara hastened to set up a meeting with their partner company. The 9-month performance period would be over in a flash, so they had better get started! Fortunately, they were sure they knew how to solve the problem, so it was just a matter of explaining the theory to their colleagues in the company and figuring out how to do nice simulations that would make the program managers happy.

But shortly after their first meeting with the company, their excitement turned to frustration: their university was refusing to sign the contract. The problem was the "approval for public release" clause: according to the university's contract office, prepublication "review and comment" was OK, but "approval" was not OK. Megan and Barbara argued that it really didn't matter in this case, since no students would be involved and they weren't planning to publish anyway, but the university contract office was adamant. Their partner company was equally adamant that the "approval" requirement was simply flowing down from the sponsor and couldn't be changed. The bickering went on for months, until finally the company got permission from the sponsor to team up instead with a research institute at a different university. Megan

and Barbara were dropped from the team.

To Report or Not to Report

Faculty collaborators Ted and Amir were having dinner with their government lab colleague Tom, when the conversation turned to the issue of Chinese and Iranian students working on government projects. Ted, who had spent sabbaticals at Department of Defense labs, commented that he would send the names of such students to the security office at the lab. Amir, who had recently become a naturalized citizen, objected "No, you shouldn't do that. These students come here to study, and it could be very intimidating to them to be put on a government 'watch' list." Tom countered "No, you do have to report them. We don't know whether they're really here to study or whether they're trying to collect information about US defense capabilities."

The conversation went on to other topics, but a few months later, the issue came to a head when Ted asked for the names of the Chinese students on the joint contract he had with Amir. Amir protested, but Ted insisted on reporting the student names anyway, saying that it was required for him to maintain his security clearance. Amir filed a formal complaint through the Human Resources department, which charged Ted with discrimination and conflict of interest. Although the university eventually dropped the charges, Ted no longer collaborates with Amir.

The Issues

These two stories highlight some serious issues facing universities. These issues, which are also topics of national discussion, have to do with the degree to which we are willing to give up our ideals of equality, privacy, and the open flow of information in order to gain security, knowledge, and funding.

Equality versus Security and Funding

We would like to treat everyone equally. But in fact it is part of a teacher's job to discriminate: every time teachers assign grades, they are discriminating between students. It is only when discrimination is based on certain specific innate qualities, such as race, gender, or national origin, that it becomes illegal.

Some universities have policies against discrimination on the basis of citizenship. But government regulations in fact require discrimination against foreign nationals, who for example are required to have passports and paperwork showing that they are in the country legally. When matters of national security might be involved, there are more stringent regulations regarding foreign nationals, and for good reasons. In particular, many of us would be concerned about students from Iran who come here to study nuclear technology. Other returning foreign students are closely debriefed by their government's intelligence agencies.

In Ted's case, he was following instructions he had received with his security clearance, directing him to "report all foreign contacts". In this sense he was required to discriminate against foreign nationals, whether or not the university had a policy prohibiting such discrimination. This was indeed a conflict of interest for him, one that had been created by university policies that were in conflict with federal regulations.

Privacy versus Security

We all want privacy, but what about terrorists? How do we know which ones are the terrorists and spies if everyone's information is private? There are government regulations protecting privacy: for example, FERPA (Family Educational Rights

Privacy Act) restricts the information that a university may give out about a student. But professors with security clearances must report certain interactions with foreign nationals, even if they are students. Ted thus faced a dilemma in attempting to comply with conflicting federal regulations.

Open Flow of Information versus Relevance and Funding

Universities are in the business of producing and disseminating information, but what about, for example, research conducted collaboratively with a company? Companies, certainly, want to keep some information secret in order to maintain their competitive edge. Any university that refuses to respect company confidentiality will soon find itself with no industrial research partners.

Similarly, the government has decided that certain information (such as how to build a nuclear weapon) should not be freely available. This information is subject to the International Traffic in Arms Regulations (ITAR), which restrict the export of sensitive defense technology. And "export" includes simply letting a foreign national see sensitive work; in particular, giving a public talk or publishing a paper constitutes an "export".

The Fundamental Research Exclusion

ITAR compliance is particularly tricky for universities because of the Fundamental Research Exclusion clause. If there are no restrictions on publications, and no restrictions regarding which personnel can work on a project, then the project is assumed to be fundamental research and is not subject to the ordinary ITAR restrictions. This motivates universities to refuse any contract with clauses that might restrict publica-

tion of research results. In particular, this was the reason that Megan and Barbara's university refused to sign a contract with a publication "approval" clause.

The Fundamental Research Exclusion motivates universities to preserve the free flow of information. But insistence on keeping the flow of information completely free is incompatible with classified or industry-proprietary work. To the extent that universities insist on openness, they cut themselves off not only from the funding associated with classified and proprietary work, but also from the corresponding knowledge. One estimate is that 25-30% of all technical knowledge is either classified or proprietary. Thus to the extent that universities insist on complete openness, they cannot accomplish their mission of providing state-of-the-art training to their students and producing cutting-edge knowledge.

The Need for Clear University Research Policies

Universities must decide where they want to position themselves on the continuum between openness and relevance. Typically it is a university's policy on export control that is indicative of how it has positioned itself. Some universities, generally those that concentrate on the liberal arts, have opted for complete openness. Others, for example many of those with strong engineering programs, indicate a willingness to work with ITAR projects, and many have developed policies in which researchers put together Technology Control Plans to ensure that they remain ITAR-compliant. Other universities go so far as to hold clearances for their faculty and provide facilities for classified work. The decision is not only a philosophical one but also an economic one: the university might gain more research funding by allowing restricted work, but it will also spend more on legal advice to remain ITAR-compliant.

It is incumbent upon universities not only to establish clear and consistent policies, but also to communicate those policies to faculty. If Megan and Barbara's university had announced a policy that valued openness over relevance, the two faculty members might never have wasted their time putting together a STTR proposal. Or if their university had developed a more flexible policy, the two collaborators might have gone on to successful Phase 2 work and obtained more and bigger contracts. The difficulties experienced by Megan and Barbara were largely due to their university's not having developed and communicated clear policies.

Similarly, if Ted and Amir's university had non-discrimination policies consistent with US law, their Human Resources department would not have charged Ted with discrimination. If their university legal office had been knowledgeable about government security regulations, the university could have developed policies regarding privacy versus security that accommodated the reporting requirements for government security clearances. In that case, their Human Resources office should have been aware that security reporting was not illegal discrimination and was not a conflict of interest. Clear university policies that were consistent with federal regulations could thus have preserved the working relationship between Ted and Amir.

Recommendations for Faculty Members Caught in the Middle

It is better to be in conflict with the university than in violation of federal law. Consequently, faculty with access to sensitive material should follow government security regulations even if their universities do not understand those regulations.

Faculty members wanting to do restricted (ITAR

or proprietary) work should check their university's policies on export control, which are usually posted on the university research policy web site. If it is the university policy to do no work whose publication might be restricted, then faculty members can save themselves the trouble of writing proposals through the university for any such contracts. One option, of course, is to move to a university with more compatible policies; this is what Ted eventually did.

If moving is not an option, then faculty can still do restricted work as a consultant for a company. During the academic year, faculty are typically restricted to consulting for no more than one day per week, but they can spend summers and sabbaticals working for a company or laboratory. Supporting students through a company, however, can be tricky because of potential conflicts of interest. One approach is for the company to make a restricted gift to the university, with the stipulation that the money be used to support a particular student's work. Megan pursued three different options: she started her own small company and submitted proposals to the Small Business Innovation in Research (SBIR) program, she established a consulting relationship with an existing company, and she obtained a visiting research professorship at a university with facilities for classified work.

Except for the names, the above stories of Megan, Barbara, Ted, Tom, and Amir are reports of actual events.



***Is God A Mathematician?* BIG Questions and BIG Events at the San Diego JMM**

Phil Gustafson, Chair
BIG SIGMAA

The 2013 Joint Mathematics Meetings will take place in San Diego, January 9 – 12 (Wednesday – Saturday), 2013. BIG SIGMAA has an exciting array of events scheduled for these meetings, including our Guest Lecture given by Mario Livio (“Is God a Mathematician?”) and a slate of interesting talks for our paper session.

This conference is reported to be the largest mathematics meeting in the world, with over 2900 abstracts submitted (according to <http://jointmathematicsmeetings.org/jmm>, the conference website). This is certainly a large gathering, and we are indeed pleased that BIG will be part of it all.

The summary of BIG SIGMAA activities can be found at the /jmm2013/2141_sigma/ path at the following web address:
<http://jointmathematicsmeetings.org/meetings/>.

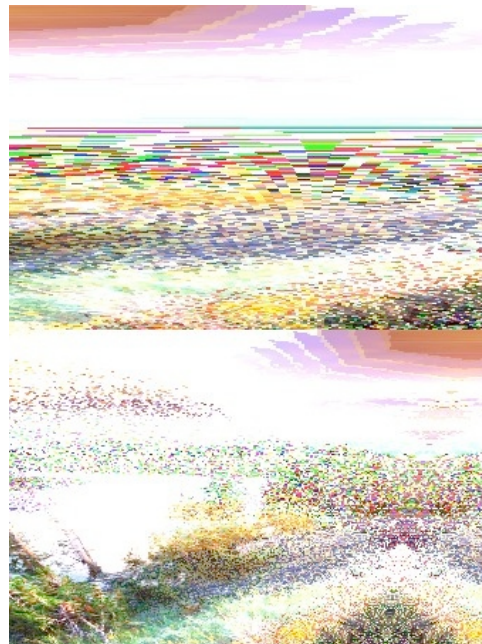
While the conference starts on Wednesday, our activities begin Friday evening, which are then followed by a paper session on Saturday; see below for the times and rooms. You are encouraged to come and participate in all of our events. We hope to see you there!

Friday January 11, 2013, 5:00 p.m. – 8:00 p.m.
Room 4, Upper Level, San Diego Convention Center:

- 5:00 – 5:45 p.m. *Business meeting.*
- 6:00 – 7p.m. BIG SIGMAA Guest Lecture:
Is God a mathematician?, Mario Livio, Space Telescope Science Institute.
-

Here is Mario’s description of his talk:
“For centuries, mathematical theories have proven uncannily accurate at describing - and predicting - the physical world. What is it that gives mathematics such powers? I will thoroughly review this question in my presentation (based on my popular book of the same name). The talk will span such fields as mathematics, cosmology, physics, and the cognitive sciences, and will attempt to answer an accessible and lively account of the ideas of some of the greatest mathematicians and scientists in history, from Archimedes to Galileo and Descartes, and from Newton to Hilbert and Godel, on up to the present day. Along the way I will discuss another question with which mathematicians, philosophers, and neuroscientists have struggled for centuries: Is mathematics ultimately invented or discovered?”

7:15 p.m. *Reception.*



Complex Plane, by Collin Carbno

Saturday January 12, 2013, 8:00 a.m.-10:55 a.m.

Room 5A, Upper Level, San Diego Convention Center

MAA Session on Mathematics Experiences in Business, Industry, and Government

Organizers:

Carla D. Martin, James Madison University
martincd@jmu.edu

Phil Gustafson, Mesa State College
pgustafs@coloradomesa.edu

Michael Monticino, University of North Texas

- 8:00 a.m.
[Applying Mathematical Tools in Public Policy: Opportunities at the Intersection of Mathematics and Policy.](#)
Salaeha Shariff, American Association for the Advancement of Science
Eric Bone*, U.S. Department of State
Sonja Sandberg, Framingham State College
(1086-J5-2476)
- 8:20 a.m.
[The automated scoring of constructed-response mathematics test questions: Why humans sometimes disagree with the computer.](#)
James H Fife*, Educational Testing Service
(1086-J5-577)
- 8:40 a.m.
[Bank Capital Models and Bivariate Normal Probability Calculations.](#)
Dale T Smith*, Fiserv., Risk & Compliance
(1086-J5-80)
- 9:00 a.m.
[Increasing efficiency is forward-picking in large-scale military warehouse.](#)
Ashok K Deb*, U.S. Military Academy

David Gohlich, U.S. Military Academy
(1086-J5-1792)

- 9:20 a.m.
[Balancing Research Interests with Project Goals at the National Institute of Standards and Technology.](#)
Bonita V Saunders*, National Institute of Standards & Technology
(1086-J5-1946)
- 9:40 a.m.
[Making Mathematics "Real" for Students.](#)
Joy Lind*, University of Sioux Falls
Darren Narayan, Rochester Institute of Technology
(1086-J5-373)
- 10:00 a.m.
[The Greatest Scientific Achievements of The Hubble Space Telescope.](#)
Mario Livio*, Space Telescope Science Institute
(1086-J5-378)
- 10:20 a.m.
[Modeling Terrorist Activities.](#)
William P. Fox*, Naval Postgraduate School, Monterey, CA 93943
(1086-J5-580)
- 10:40 a.m.
[Math in the City: Integrating the Classroom and Applications in the Local Community.](#)
Petronela Radu, University of Nebraska-Lincoln
Sandeep Holay, Southeast Community College
Joe Geisbauer*, University of Nebraska-Lincoln
(1086-J5-2594)