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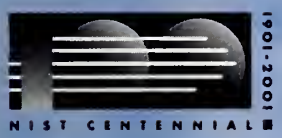
Proceedings

NIST Centennial Standards Symposium

Standards in the Global Economy: Past, Present, and Future

Editors:
Mary Jo DiBernardo
Belinda L. Collins
Walter G. Leight



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Proceedings of the NIST Centennial Standards Symposium

Standards in the Global Economy: Past, Present, and Future

Mary Jo DiBernardo
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Office of Standards Services
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Abstract:

On March 7, 2001, in honor of its 100th anniversary, the National Institute of Standards and Technology sponsored the NIST Centennial Standards Symposium. Representatives of the public and private sector celebrated the role that NIST has played in standards in a variety of industry sectors and in partnership with numerous organizations. This publication is a compilation of speeches and presentations from multiple speakers on various standards-related topics.

Key Words:

Building & Construction, Centennial, Conformity Assessment, Global Standards, Information Technology, Manufacturing, Materials, National Standards Strategy, Optical Sensing, Partnerships, Semiconductors, Standards, Standards Developing Organizations, Symposium, Transportation.

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Introduction

The National Institute of Standards and Technology (NIST) and the Office of Standards Services in Technology Services conducted this Symposium on Standards in a Global Economy as a celebration of the long-standing partnership of industry, standards developing organizations, government agencies, and NIST. We spent the last 100 years working on it (!) with the hope that the participants would enjoy it as much as we enjoyed planning it. NIST has considered itself very lucky over the years to have had the best partners that any organization could want. This Centennial Symposium highlighted that incredibly positive relationship.

Through this unique partnership we have developed together, standards that have met, and will continue to meet, needs for sound and innovative technology and for protection of health, safety, and the environment. The developmental systems that have evolved through these partnerships have met both national needs and global needs. These standards are driven by need, not mandate, and are created by industry, experts, academics, government representatives, consumers, and others. The voluntary standards they produce are frequently embedded in national, state, and local laws and regulations, as well as in products and services used around the world. Interest in the unique U.S. system was evidenced by the attendees at this Symposium from around the world, including 20 professional experts from the telecommunications industry in Russia and the Newly Independent States.

This Symposium was designed to provide examples of past successes in standards, timely discussions of trends, and identification of future needs in a variety of important technological and policy areas. Participants included leaders in the global policy and standards arena, with representatives of the American National Standards Institute (ANSI), the International Organization for Standardization (ISO), the International Electrotechnical Commission (IEC), the American Society of Mechanical Engineers (ASME), the American Society for Testing of Materials (ASTM), and the National Fire Protection Association (NFPA). Key representatives of industry and government also presented their perspectives on standards.

Central to all the presentations was the concept of partnership. All speakers agreed that standards are effective only when they are developed by those who will use them; when the process is open, flexible, and meets the needs of the users. In the United States, government has not driven the process, but rather has served as an active participant and willing beneficiary. We have challenged standards developers to create an environment in which all interested parties can come together to use sound research and technology as the foundation for standards in a wide variety of technologies.

Since its beginning, the U.S. standards system has been rooted in flexibility. Symposium speakers discussed various processes for developing standards, including the formal standards process, the fast-moving consortium approach, hybrid partnership projects, and pre-standardization research. These options allow standards to be created to meet the differing needs of different sectors. Concerns about speed and timeliness may drive one process; concerns about health, safety and protection drive another approach; and concerns about accuracy and reliability drive still another. Yet, these approaches borrow from one another in a fluid fashion depending on the demands of a particular sector or interest group. The resulting standards must also meet the test of a business case: Will they satisfy purposes for which they were designed? If so, they will be used; if not, time and money will have been wasted to produce documents that sit, untouched, on shelves.

Against the backdrop of partnership, the Symposium covered an amazing breadth and depth in current and past technical activities in standards. These activities were organized along sectoral lines since that is the way that we in the United States approach standards. Speakers from industry, standards developing organizations, and NIST discussed standards, achievements, and the future in a variety of areas. These included telecommunications, information technology, semi-conductors, optical technology, transportation, materials, manufacturing, building and construction, and fire safety. They stressed the importance of a strong foundation in measurements and research, as well as the need to forge a partnership among researchers, industry, government, and other affected parties to create standards that will be used. In addition, many of the presentations attempted to quantify the benefits realized from standards in terms of reduced cost of testing, increased interoperability for components in a supply chain, and increased safety with decreased loss of life.

The technical presentations were followed by a panel discussion on the U.S. National Standards Strategy, which was developed by ANSI in collaboration with many organizations present at the Symposium. The National Standards Strategy provides a framework for U.S. interests to improve U.S. competitiveness globally, while continuing to provide strong support for domestic markets. It builds on the traditional strengths of the U.S. approach to standards with its focus on industry sectors. The Strategy sets forth challenges as the U.S. standards community works to ensure that the United States continues to play a major role in standards issues worldwide. Under the ANSI umbrella the Strategy was created by industry, standards developing organizations, and government agencies working closely together. This continuing partnership will make the goals of the strategy a reality.

The Symposium closed with an historical perspective that reminded attendees that standards enable us to specify the function, performance, and reliability of a product or system. With this underpinning, science, technology, innovation, and human satisfaction will go forward to meet global needs in all sectors.

Belinda L. Collins
Deputy Director, Technology Services
National Institute of Standards and Technology

Global Standards: Policies & Politics

Opening Remarks

Richard F. Kayser
Director, Technology Services
National Institute of Standards and Technology

It is my pleasure to welcome you this morning to the NIST Centennial Symposium on Standards in the Global Economy on behalf of Dr. Karen Brown, Acting Director of the National Institute of Standards and Technology. Karen is unable to be here today, but she sends her kindest regards and best wishes for a successful symposium.

We are honored to have five of NIST's former Directors here today—Lou Branscomb, Ernest Ambler, John Lyons, Arati Prabhakar, and Ray Kammer.

Today is a celebration of the long-standing partnership between industry, standards developing organizations, and NIST. Through this partnership, we've developed standards that have met and will continue to meet U.S. national and international needs for sound technology and for the continued protection of health, safety, and the environment.

As you know, NIST staff members have long participated in numerous technical committees, working groups, and advisory groups of many standards developing organizations, both in the United States and throughout the world.

In today's Symposium, you will hear examples of past successes and suggestions for new topics and new standards to meet the needs of the future.

First, we will hear from selected leaders in the global policy and political arena . . . and we are pleased to have with us here today the leaders of ANSI, ISO, and IEC . . . as well as the leaders of many other standards developing organizations.

For the second part of the program, we've selected a sectoral focus since that's the way the United States approaches standards. You'll hear speakers from industry, standards developing organizations, and NIST discuss standards achievements and future needs in telecommunications, information technology, semiconductors, optical technology, transportation, materials, manufacturing, and, after lunch, building and construction, where the emphasis will be on fire and building safety.

After that, the leaders of ASME and ASTM will share with us their perspectives on standards partnerships, and in particular, on their long-standing partnerships with NIST to develop standards that meet both national and global needs.

Following those presentations, a panel of experts will discuss the U.S. National Standards Strategy, which was developed recently by ANSI in collaboration with many of the organizations attending this Symposium today.

The National Standards Strategy provides a framework for the United States to move forward to address sectoral needs within a national setting. It sets forth challenges for all of us to meet as we work to ensure that U.S. technology plays a major role in standards used worldwide and that essential requirements for protecting health, safety, and the environment are met. During the discussion, you will hear the viewpoints of industry, standards developing organizations, and government agencies as they work together to make the goals of the strategy a reality. Finally, we will close with some historical perspectives and a few observations based on today's events.

It is now my pleasure to introduce our first speaker, Dr. Arati Prabhakar. Arati is currently a partner with U.S. Venture Partners located in Menlo Park, California. From 1993 to 1997, Arati was the Director of NIST, and from 1986 to 1993, she was a program manager and then director of the Microelectronics Technology Office at the Defense Advanced Research Projects Agency. While Arati was the Director of NIST, she took particular interest in the U.S. standards process. In addition to signing the first MOU between ANSI and NIST, she took other actions that promoted a sense of community among the stakeholders in the standards area, and these actions prepared the soil from which the National Standards Strategy ultimately emerged.

Global Standards in a Shifting Economy

Arati Prabhakar
Former Director, National Institute of Standards and Technology

INTRODUCTION

Good morning. I was so delighted when Belinda asked if I would join you today, because I thought that I would have a chance to see a lot of familiar faces that I hadn't seen in a number of years. I started seeing people yesterday and again this morning when I walked in. I kept seeing people that I hadn't seen in all this time, and it really has been just a wonderful reunion for me.

Since I left NIST four years ago, I have been involved in a whole host of new adventures, none of them explicitly in the standards world, and yet I found that everywhere I went, standards were just pervasive. They were in every aspect of the things that I was trying to do. The first thing I did when I left here was to serve as the Chief Technology Officer in a $2 billion corporation that was selling materials and components. After that, I ran a laboratory that was generating really amazing new ideas on how consumers would use information technology and new applications in their homes. As Rich Kayser mentioned, literally just two weeks ago yesterday, I joined the Venture Capital firm. Again, everywhere I turned, I would find while we were going about our business that standards just were pervasive in everything that we were doing. It was every different facet of the standards that you all are involved in building and developing, and propagating through the world. Standards issues, as you won't be surprised to hear, came up in terms of manufacturing quality issues, in terms of the safety of products that people were going to use in their cars and in their homes, and in terms of information technology.

Interoperability standards are key in so much of the information technology arena. As we thought about how consumers would use new technologies, we realized we would really need things that consumers could just plug and play and make happen. The interoperability of those things became incredibly important. Most recently after I joined U.S. Venture Partners, we spent four days last week at our annual off-site planning for the next year, and an amazing amount of our conversation had to do with what is going on in the internet infrastructure. Again it really struck me how key standards will be to take us to the next level—to really start to get the efficiency in that infrastructure that is going to let us see the scaling and the kinds of functional business models that will help us move forward in that arena.

So while I have left NIST, where standards are its bread and butter, I still find that I am immersed in a world where standards matter every single day, and in just in an enormous variety of ways. I continue to be grateful to all of you and the communities that you represent for making that possible. Every time I am in a meeting and someone starts talking about standards, inside my head I am picturing this huge community.

I think that a lot of people do take standards for granted. I have always argued that one of the great successes of a technology infrastructure activity is that when you succeed that people take you for granted. In many cases, that is the outstanding outcome. The fact that in all of these conversations that standards do continue to come up, means that of course that our work is never done. I think that we have to just recognize that this work is never done, particularly today when we live in a time of continuing rapid progress and technologies across the board; and when we live in a period of expanding globalization. We can only come to milestones. We can never really come to a finish line, which I think is good news, because it is going to keep all the momentum in this business moving for quite some time.

THE STANDARDS COMMUNITY—10 YEARS AGO

So when Belinda asked if I would speak here, I started thinking about the standards part of the work that I had done at NIST. As you know, NIST has been building on its strong foundation as the National Bureau of Standards for the first many decades of its life, while expanding into many other arenas. The absolutely necessary foundation for that, I believe, is the standards activity.

These thoughts led me to remember what my first exposure was to the U.S. standards community. I started interviewing for this job here at NIST, while I was still over at DARPA in my previous life, where I thought much more about technologies, but not really very explicitly about standards, or the process by which we got standards. I was able to talk to some of my family members about this adventure that I was thinking about launching into, and was talking with my cousin one night. At that time, he was working at a Congressional Agency, the Office of Technology Assessment, where I actually had also worked at one time. When I told my cousin about going to NIST, his eyes got really wide, and he said "did you see the report that OTA had just done on standards," to which I said, "no, I hadn't."

My cousin got the report for me, and when I looked at it—you know I had worked in the congressional agency, and you all know what government reports are like. They are usually extremely dry documents, with many facts, but not much life. But this particular report was about standards, the standards process, and looking at how it worked in the United States. As I read, I realized that while standards may seem like a dry topic and a dry government report, there was actually an incredible teeming, exciting story in here, and not all of it was completely positive.

As I was reading the report, I came across a paragraph in the summary that talks about personality conflicts in the standards community, and I quote, "some dating back a number of years." It goes on to say there is little trust among the leadership. People characterize one another in highly acrimonious terms. And I thought, "my, that is sort of interesting." Then I noticed that there was a footnote to this sentence, and down in the footnote was this somewhat amazing explanation. It went on to say that among the terms used during the OTA interviews to describe members of the community were "scum ball," "liar," and "sleeze," to name a few. And I thought, "my word, I thought that this was a mild-mannered standards community, and everyone must love each other and get along, and how can this be?" The report went on to say in the footnote that "*some reviewers of the OTA draft believe that it is inappropriate to use such terminology in a government report. However, many of these same people argue that OTA has exaggerated the turf battles and personality conflicts within the standards community. Because these words illustrate the intensity of feeling and negative tone of the competition among standards organizations, OTA chose to retain them in the final document.*"

I came to realize through this minuscule footnote that not only was there an immense battle raging in the standards community apparently, but they also had picked a battle with the author of this report. It seemed like it must have been quite an interesting time. The report went on to describe the impact of this situation, where we in the United States have an enormous number of people working very, very hard on standards, but in fact where there was also a deep sense that things were not meshing in a way that was most advantageous to our industry, to our economy, and to our society as a whole. Outside of the United States, there was also a feeling that the mess of the situation that we had here, to be very blunt, was also having a very important impact at the global level, and that we were not able to play the role that we needed to play as a major economy in the global standards process. It was actually a fairly daunting indictment of a situation that I thought certainly needed some improvement as I read it. So I read all of this, and I thought, "oh, I thought standards were going to be the easy part of going to NIST. What have I gotten myself into?"

NIST ROLE IN STANDARDS

When I arrived at NIST, one of the things that I found was that Bob Hermann was on my visiting committee (the Visiting Committee on Advanced Technology) for NIST. He was also very deeply involved with the American National Standards Institute (ANSI). In talking with him, and talking with many other leaders in this community who really saw the necessity for a really powerful, capable, fully functional standards process in this country, I came to realize that this needed to be one of my key priorities. I had to try to play NIST's role in this national system of standards organizations to make this be a much more powerful process than we had. I came here to NIST to do a number of things, and thought a lot of my focus as I came in would be specifically on building the Advanced Technology Program into a national scale effort; building the Manufacturing Extension Partnership to a national effort; and taking Baldrige to the next level of education and health care. While I spent a lot of time on those things, and I feel very proud of the accomplishments that we made in those areas, but standards were always on my short list of the things that I would put time and effort into.

By teaming up with Sergio Mazza, who through a miracle of timing had come to ANSI as its President and CEO at the same time that I came to NIST, I really feel that we were able to start making some changes in the relationships.

So as I look at the standards community, what has not changed is that we continue to have hundreds and thousands of deeply dedicated individuals. NIST contributes to that process, but all of your organizations and industry also contribute. People at all different levels are really getting in there and rolling up their sleeves and trying to make a difference through the standards process, where I think we have made great progress.

I feel very, very pleased to have been able to contribute to that, in bringing the organizational structure and the leadership in alignment in a way that really lets us tap the power of all of these people who are really earnestly working very, very hard to use standards to make a difference. During my early time at NIST, around '93, Sergio Mazza and I both were able to use the fact that we had come out of different backgrounds, and that we didn't really know a lot about the standards community to say, look, let's see if we can move to a new mode of operation. We really felt that there was too much at stake not to really take this whole process to a

new level, and to a much more productive level. To my delight, people across the community were willing to dive in and help make this change happen.

NATIONAL COOPERATION—THE PATH TO THE FUTURE

I believe that we started down a very good path. Among other things, we were able to sign as Rich Kayser mentioned—the first MOU between ANSI and NIST. That became a platform for building a very good new relationship between the two organizations, as well as a platform for reaching out into the much broader set of organizations across the community. I was very happy to notice that Ray Kammer, who was the NIST Director after me, and Mark Hurwitz, who is the new president of ANSI, were able to sign a third revision of that MOU just last December. So that to me is a very encouraging sign that we are continuing on this path.

I was also very, very proud to see the work that all of you had done that culminated in the National Standards Strategy. First of all, I love the cover, because the picture of chess moves I think is exactly what this business is about, and so I thought that was a wonderful image. As I started reading it, I was truly amazed at the strength of the convictions that were expressed in that document. So often when you have a document put together by many, many people, —you know, a camel is a horse built by a committee—that I was a little fearful of what I would find when I folded the cover open. But I was delighted at the strength of the statements that you all were able to make as a group, and the things that you were able to commit to as a group. It gave me great confidence that we have now reached a new plateau, a new level for the way our standards community in the United States works together.

I feel very, very, good about that progress. As I think about what lies ahead—my view has always been that particularly in the arena where we all live, where the world is changing very rapidly around us—it really is not an option to stand still. So, in going forward, it is a time to celebrate a lot of accomplishments. It is also a time to rev up our engines for the next round, because if we don't keep this momentum moving forward, the only thing that will happen is that we are going to slip back into a way of working that is not nearly as effective as the path that I think we are on.

There are in fact a number of important challenges that lie ahead. Just the work of keeping the technical quality of standards, and the standards process, at the highest possible level is a full-time activity. NIST, of course, has always taken seriously its role in providing the measurement infrastructure, the measurement standards, and much of the technical basis that underpin standards. I am very pleased to see the leadership since I have left also focusing very hard on that, since it is something again that reaches across the whole community.

Participation in the standards process is another thing that we can't take for granted. In companies, in all parts of the economy, it is very, very difficult, particularly as the economy goes through the shifts that we now are going through. It becomes increasingly difficult to find the resources to have people travel and to have an individual put the necessary cycles into the standards process to create useful standards. Yet, those are things we really can't step back from, because the impact ultimately for us as an economy and as a society is just too devastating if we don't have that full participation. Standards set in a vacuum, or standards set off in a corner by people who are not fully engaged in the technologies, the businesses, and the economic and social issues, are not standards that will work. Full participation continues to be an ongoing challenge. Keeping a focus on the objective of the standards process is also essential. After all, we are not making standards just because we want to write something down. We are doing it because of the role that standards play in facilitating the growth of our economy in building the social structures that help ensure health, safety, and the quality of our environment, and keeping an eye on those objectives is extremely important. It is very easy to slip into just looking at the process without remembering why we are doing it, and how we need to be optimizing it. I think that continues to be an incredibly important piece of the puzzle.

A key fact as we go forward is that our world economy becomes more and more global every single day. Thus, in our global economy, having a strong U.S. standards process is an incredibly important first step, but it is only a first step.

We are so fortunate today to have people from all different parts of the world participating in all different aspects of the standards process. They are continuing to build those relationships, find the best practices, and use the best ways of thinking about how to move standards forward from around the world. That continues to be a very important opportunity, and a very important challenge. I think we can be far more effective today because of the fact that we have straightened out our national standards system as well.

So as we stand here today celebrating this centennial, we can take pride that we have built a very, very powerful base on which to stand. We have put in place so many of the features that will be necessary to take us forward to the next many steps. NIST, your organizations, and our inter-relationships have all the key ingredients. It should be a very interesting next decade and next century, and I really look forward to continuing to work with all of you as we go forward into those challenges.

Thanks very much, and I hope that you have an excellent meeting.

ANSI's Role in ISO and IEC

Oliver R. Smoot
Chairman, ANSI Board of Directors

Introduction

Good morning, ladies and gentlemen. For those of you whom I have not had the opportunity to meet, I am Oliver Smoot, chairman of the American National Standards Institute (ANSI) Board of Directors. It will be my pleasure to introduce to you ANSI's role in the global standardization activities of the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC) and to comment upon the importance of close public- and private-sector cooperation in these important bodies.

It is also my honor, on behalf of ANSI's members and staff, to extend our congratulations to NIST on the occasion of its Centennial celebration. It is not often that one gets to celebrate such an anniversary, and I am very proud to be a part of this special Symposium in recognition of the event and in recognition of the role of "Standards in the Global Economy."

The success of U.S. interests in international standards development is only possible through a strong relationship between the private and public sectors. The positive working relationship between ANSI and NIST is crucial for ongoing success. On December 27, this relationship was further strengthened when ANSI's president, Dr. Mark Hurwitz, and Mr. Ray Kammer, recently retired director of NIST, signed the latest in a series of Memoranda of Understanding between our two organizations. The new MoU is intended to improve domestic communication and coordination on voluntary standards issues among all parties in the U.S. Our goal is to increase the effectiveness of U.S. government agency participation in the national and international voluntary standards-setting process.

Past

Before we explore the future of standards setting, let us first look at the past.

Many of you know about ANSI; its role as coordinator of the U.S. voluntary standardization system, and its role as the U.S. representative to ISO and IEC. But few of you may know that discussions to coordinate U.S. national and international standards development date back to the first decade of the 20th century.

An international meeting of leading scientists and pioneer industrialists was held in 1904 in St. Louis, Missouri. This meeting led to the establishment in 1906 of the International Electrotechnical Commission, the body responsible for the development of the world's electrical and electronics standards. In 1907, the U.S. National Committee (USNC) was formed for the purpose of participating in the IEC. Today, USNC members represent many different sectors of the electrotechnical industry.

Though efforts to develop a coordinated national standards system were also underway, it was more than a decade later, on October 19, 1918, when our nation's nongovernmental standardization system was "officially" born—with ANSI as its coordinator. Founded then as the American Engineering Standards Committee, the AESC was created by five engineering societies and three departments of the federal government—among these was the National Bureau of Standards (now NIST), on behalf of the Department of Commerce. Together, these diverse groups resolved to form a centralized committee responsible for ensuring the development of national standards. These standards were to be produced in a manner that eliminated or minimized waste, duplication of efforts and conflict.

Several years later, in 1926, AESC hosted a conference that created the International Standards Association (ISA), an organization of national standards bodies that would remain active until World War II. Shortly after the War, the U.S. standards community—working in the body now known as ASA (the American Standards Association)—joined with representatives of 25 countries and in 1946 formed the International Organization for Standardization (ISO). By definition, ISO is a worldwide federation consisting of national standards bodies—now, these bodies represent nearly 140 countries from around the globe. Work within ISO covers all areas of technology with the exception of those handled by IEC, and a third international standards body, the International Telecommunication Union (ITU).

Today, more than 80 years since the founding of the AESC, nearly 1000 members from U.S. industry, academia, professional societies, trade associations, consumer representatives, and government come together under the ANSI umbrella to participate in national and international standards-setting committees, conformity assessment programs, and related activities.

The U.S. voluntary, private-sector-led system we have created is recognized as one of the most effective and efficient in the world today. Our open, decentralized system of standards, testing, and certification mirrors America's culture and commitment to free enterprise. As with our nation's culture, unity does not depend on unanimity, and decisions are founded on consensus with the market determining the optimum allocation of resources.

Present

Given the pace of today's rapid technological changes, increased competition and globalization of markets, a single set of standards recognized worldwide holds increasing strategic significance. Establishing criteria for goods and services, standards impact productivity, economies of scale, and the pace of product development. Standards can also facilitate marketplace access, improve the safety and health of global citizens, and protect the environment for us, for our children, and for our children's children.

The world economy is changing, and the U.S. voluntary standardization system must evolve to meet these new challenges. ANSI's domestic and international relationships and activities offer unique opportunities to confront revolutions taking place in the standards arena.

The Institute's role in the global standardization system is multi-faceted. As the U.S. member body, ANSI participates in 78 percent of all ISO technical committees. ANSI is one of ISO's five largest members, which entitles the U.S. to a seat on the ISO Council, a management body of the organization. Similarly, as one of the four member bodies reflecting the most significant responsibility and productivity within the ISO technical committee structure, ANSI is also entitled to consecutive terms on the Technical Management Board, the group that oversees technical committee operations.

Via the U.S. National Committee, this country participates in 91 percent of all IEC technical committees and provides the chairmen for a significant number of these groups. Only one other country—France—holds as many technical committee secretariats. The President of the USNC serves as one of the 15 members of the Council Board, a decision-making body focused primarily on IEC policy issues and the U.S. is one of six permanent members of the 15-member Committee of Action—the group responsible for the management of the IEC's standards work—and one of twelve members of the Conformity Assessment Board—the body responsible for management of the IEC's conformity assessment activities.

The U.S. has taken a strong leadership role within both ISO and IEC and has been very successful over the years in achieving its objectives. By having strong representation on the governance and advisory bodies of these organizations, the U.S. has been able to effectively influence policies and decisions concerning the direction and overall development of global standards.

ANSI's representation of U.S. interests in ISO and IEC does not come without a price. Our combined dues to the two organizations are approximately $2 million per year. The Institute expends an additional $2 million per year in support of related international programs and efforts.

In June of 2000, ANSI was awarded a grant of $500,000 from NIST to further U.S. interests in areas of international standardization and conformity assessment. Funds were made available with the active support of the House Committee on Science. Congress specified that the grant be used solely for international standards activities, so ANSI allocated the grant money to help pay ISO and IEC dues and to support its participation in the organizations' policy-making bodies.

Commenting on the grant, Ray Kammer said, "Regular U.S. representation at the grass roots level and in key policy-setting committees is critical to ensure consistency of international standards with U.S. standards and practices. Just as many nations are doing, we must be alert to the potential that competitors will use global standards to advance their economic interests and to impede other countries' access to export markets. The grant will help ANSI to represent the United States effectively in ISO and IEC and in the regional activities that often result in international standards."

As a point of comparison, among the United States' top 10 trading partners, levels of government support

for national standards organizations in 1995 ranged from nearly four percent (4 %) for the United Kingdom to 100 percent for Japan, Mexico, China, and South Korea. The $500,000 grant from NIST is equivalent to almost three percent (3 %) of ANSI's annual budget.

Henry Line, who at the time of the grant was serving as chairman of ANSI's International Committee, stated, "Inasmuch as standards are the common denominator in addressing the demands imposed by market forces, it is imperative that U.S. technology be appropriately positioned in all of the global forums wherein requirements are being articulated. The grant from NIST provided significant assistance in ANSI's efforts to position the U.S. at the fore-front of the international standards development community."

Mr. Line also noted that the importance of participation is underscored by the fact that today many standards issues will be resolved at the international level. For companies seeking to expand or protect markets, the ANSI federation offers a distinctive economic opportunity—the ability to influence standards that serve as the basis of product acceptance in many countries.

The basis for product and service acceptance worldwide, standardization is literally the key that can unlock markets from all corners of the globe. Thus, the importance of U.S. participation and leadership in the international standardization process, via the ISO and IEC infrastructures, has never been greater—from an economic perspective as well as from a technological perspective.

Future

As many of you know, on August 31, 2000, the ANSI Board of Directors unanimously approved a National Standards Strategy for the United States. This document, developed over a two-year period with input from a large and diverse group, establishes a framework that can be used by all interests—companies, government, non-governmental organizations, standards developers, and consumers—to improve U.S. competitiveness abroad while continuing to provide strong support for domestic markets and, at the same time, addressing key quality-of-life issues such as the environment. It builds on the strengths of the U.S. system by proposing a set of strategic and tactical initiatives within that framework that can be used by all interests to meet national and individual organizational objectives.

In line with the National Standards Strategy, the U.S. is moving forward with its commitment to lead the international community, specifically the ISO and IEC systems, further toward a flexible, sector-based structure and management and in further stream-lining their processes and operations. Our goal is to promote our vision of a single set of internationally recognized, technically valid standards for each industry sector. Reaching consensus in a global environment will require compromise and a mindset that seeks out win-win solutions.

However, we are a community recognized for our vision and our place at the leading edge of the technological revolution. When we apply our creative influence inward, to our own processes, standardization and conformity assessment programs can appropriately influence the emergence of new technologies.

We have extensively applied information technology both at ANSI and at ISO and IEC to shorten administrative processes and to make the standards approval mechanism more efficient. Probably more important than speed is the rise in accuracy and efficiency resulting from the implementation of IT tools. When used correctly, these tools will ensure that there is virtually no misdirection, misinterpretation, or delay in the expedited development and delivery of standards. Certainly, time and money has been saved, and resources are being freed for the most important component of the standardization process—the content.

By allocating resources to content, not process, we directly respond to the requests of our end-users for "*good*" standardization. And by allocating resources to speed, not administrative redundancy, we directly respond to the need for a faster "time-to-market" for standards suitable for application in a global market.

ANSI also intends to formally propose to ISO and IEC that consideration be given to separating the technical development of standards (i.e., the direct participation of technical experts) from final approval (i.e., the ballots cast by national bodies). We also intend to ask that further consideration be given to whether the current "one nation, one vote"—which ignores both decentralized and regional approaches to standardization—is still the most effective methodology for all sectors.

As these, and other, streamlined procedures are proposed, we see enhanced responsiveness as well as increased flexibility within the standards-setting process. These efforts demonstrate that the formal

voluntary consensus standardization system is responsive to identified needs while continuing to ensure the integrity of a system that has proven its importance to industry, government, and consumers.

In my opening remarks I noted that the success of U.S. interests in international standards development, particularly within the sphere of influence of ISO and IEC standardization committees, is only possible through a strong relationship between government and industry. The need for increased cooperation has never been greater.

From the ANSI perspective, the goal of an industry/government partnership should be improvement and advocation of the U.S. voluntary standards system and the strengthening of the U.S. presence in the global marketplace.

The latest MoU between ANSI and NIST will do much to further progress these goals. It will facilitate and strengthen the recognition of ANSI as the representative of U.S. interests at the international level by all participants, and it will facilitate the implementation of the U.S. National Standards Strategy. The focus on internationalization will certainly help the U.S. extend its reach of influence beyond our nation's borders.

As we fortify our cooperation, government and industry will be able to work together to protect our environment, develop more effective social initiatives, improve safety and health programs, and make improvements in a score of other areas that will result in the betterment of our lives and America's economy.

I look forward to working with you to ensure our continued success.

Thank you.

Standards Wars Past, Present, and Future
Can the Free Market Rationalize and Regulate Itself?

Lawrence D. Eicher
Secretary-General, International Organization for Standaradization

LDE AS JAMES BOND

And so to "Standards Wars." There is no need to check around for cover as I do not intend shooting at anyone, although I do hope that the points I want to make will hit some relevant targets.

As I shall be retiring from ISO in a few years, I have been thinking about my next career. Internet interactive games seem like a good niche, so I thought I would give that a try. When you attempt something new, it helps if you can make a connection to things you already know something about, so I have built on my varied experiences in standardization to design my first Internet interactive game: "Standards Wars—Past, Present and Future."

The game is still at the early design stage and I have not yet completed the software for the first working prototype. However, I brought along a demonstration version to give you an idea of what it is all about. I will be inviting you to play along with me today, and free copies are available so you can play to your own scenarios. Hopefully, that will whet your appetites enough to place an advance order to be sure you get the actual game when it hits the Net just before next Christmas.

Before we play, I need to run through two basic rules of the game that somewhat resemble the familiar rules of "Monopoly," a game many of us grew up with.

Rule 1: The first rule of the game is that free enterprise economics rule the world. This is not such a far-fetched rule when looking back over the past several decades with the growing economic predominence of free enterprise systems, led by the USA, together with the fall of the Berlin Wall and the demise of communist theory and practice across the world. Many political commentators take the position that the free enterprise system has triumphed and is now here to stay. Events still occur, now and again, that take us by surprise —however, Seattle and Porto Allegre notwithstanding, globalization economics based on the free enterprise model is clearly the safest backdrop assumption for the standards games we all like to play.

Rule 2: Standardization is contrary to the natural tendencies of free enterprise systems, which thrive on competition to produce dynamism, innovation, diversity, and abundant consumer choice. However, all great standardizers, including Herbert Hoover, the great granddaddy of NBS and NIST, have understood that if left completely unchecked, free enterprise systems can become dangerously chaotic. And, when this is the case, coherent markets will not expand easily; economic growth will be dampened, and there will be heightened risks of user confusion and injury. Without rationalization of production and supply, large reserves of scarce national resources will be wasted, and without a degree of regulation, either by governments or in the form of industry self-regulation, it is difficult to imagine how public issues of health, safety, and the care of the environment are to be handled by society.

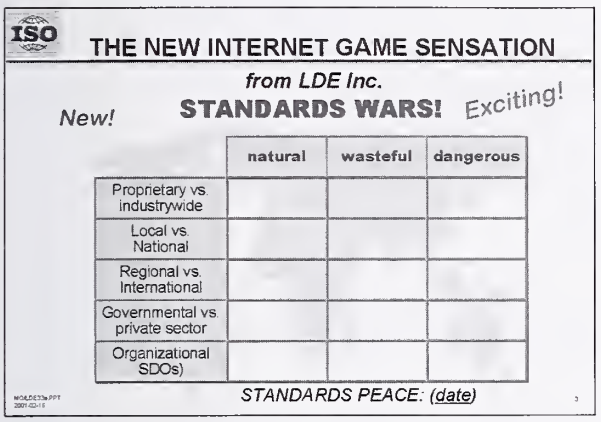
So, what is a standards war?

Given that all of us align ourselves with free enterprise economic theory and agree that standardization, while not a natural free enterprise undertaking is an essential moderator of its potential downsides, we come quickly to an appreciation that none of us has enough wisdom to individually direct the course of standardization. Such direction has also to be subject to a balance of "market and public policy needs" in every country, sector by sector, and with an appreciation of the increasingly interdependence of nations and the growing necessity to compete effectively in international markets.

Given also that the many market players, including industry and their trade associations and ad hoc fora, governments, and national and international standards organizations all have their own objectives to pursue, and interests to protect, it is fairly straight forward to see how "lack of agreement" on how and when and why to standardize would come to the fore.

A standards war, in my conception, is a state of affairs in which standardization has not yet happened, but where the evidence that it should happen is continuing to grow, sometimes to the point of becoming extremely urgent. I hope that a few examples will help to show what I intend to illustrate.

Let's have a look at the game:



STANDARDS WAR GRID

As you can see, the game is based on a grid which can be used to analyze Standards Wars: Past, Present and Future. The vertical axis is used to identify the combattants in a given Standards War. Is it an issue of proprietary vs. industrywide standards? Are we confronted with differing local and national objectives? Are we facing conflicts between larger regions like the European Union vs. U.S. or International Standards? And, to what extent are the standards issues Governmental vs. Private Sector? Or, as is often claimed, are we only fighting about which standards organizations, national, regional, or international should be developing which standards?

The grid is then divided into columns to help us analyze to what extent a particular war is a natural consequence of free enterprise diversity (and possibly not solvable with industrywide standardization) and to what extent the results of the war are excessively wasteful or dangerous.

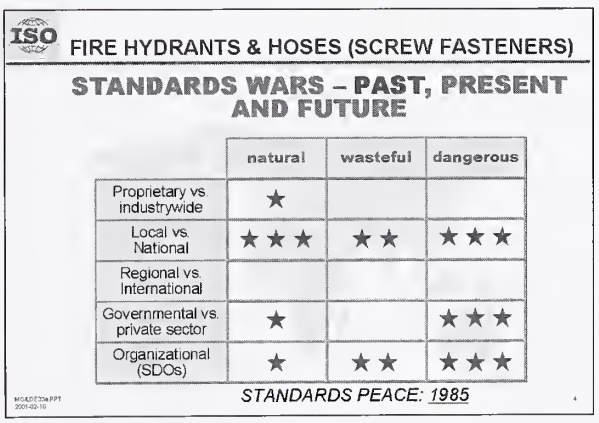
To get a better idea of how the game is played, let's look at a few examples.

First, a Standards War of the Past involving screw fasteners: specifically, of fire hydrants and hoses. This war was taking place in 1904 and its negative effects were felt most severly in the city of Baltimore. I am indebted to Albert L. Batik's book, *A guide to standards,* for this description of what happened:

"A fire got out of control and started to sweep through the city. Fire companies as far as 100 miles away rushed to the aid of the stricken city, to no avail. It was found that their hose couplings could not attach to the hydrants, nor to other hoses—there were no standard couplings. While firemen watched helplessly, Baltimore burned. This disaster was the stimulus to establish standard hose couplings by the National Fire Protection Association, and standard screw threads and other mechanical standards by the American Society of Mechanical Engineers."

Now, I need to tell you the third rule of the game—the interactive part. Players are first asked to identify themselves in one or another of the categories of combattants, and then with the use of a zero to three star ranking system to characterize the nature and gravity of the war as they see it. Finally, they are asked to identify a date when they believe the war was effectively over and a "Standards Peace" was declared. This date, of course, can be sometime in the future. When the player has registered his or her characterization, their data will be compared with that of other players, and (for a small yet to be determined fee) they can see where they came out in relation to one another.

Here, you can see my own charaterization of the screw thread war for fire fighting equipment in and around Balitmore. Naturally, I put myself in the standardizing organization combattant category. The absence of the needed standards was understandable, if not excusable, at the time because three competing screw and fastener standards existed: the British Whitworth Standards, the American "Sellers" Standards, and the Baltimore Steamer Standards. Manufacturers seemed unable to form a concensus view on which standards to follow, and because of high costs



GRID FOR FIRE HYDRANTS & HOSES

to convert, the problem could be at least partly described as Proprietary vs. Industrywide. Local vs. National government purchasing decisions were obviously part of the problem, although to my knowledge all of the governments involved expected the standards to be developed by the private sector, and that is what eventually happened at the organizational level with NFPA and ASME.

When do I think this war was over? When I first thought about it, my guess was in the early 1930's at least in the United States, until I learned that even today, fire trucks in many areas contiguous to Baltimore still carry adapters to hook two different types of fire hydrants to their hoses.

Then, some 20 years ago, I learned about the international screw thread war in ISO, which apparently started in 1947 with the creation of ISO TC 1 "Screw Threads" and went on in earnest for some 17 years before the first standard was published, and another 20 years before the definitive set of metric ISO screw thread standards were finally approved in the early 1980's.

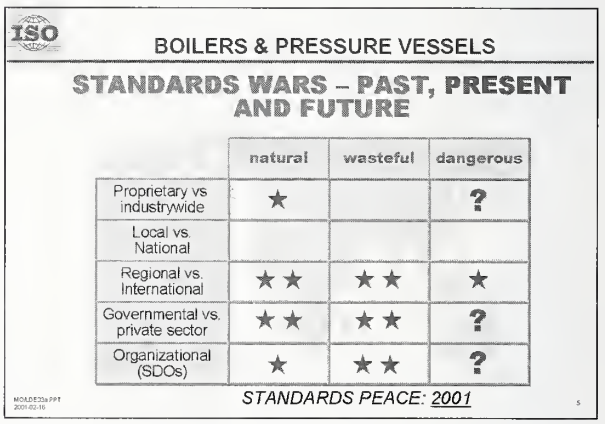
Daddy, are we there yet? Is the war over?

I think so. Now, we turn again to the self-regulating nature of free enterprise market players to voluntarily, and in their own self interest, achieve the levels of screw thread standardization they need to make their respective markets prosper.

Next, I would like to turn to an example of a Standards War that certainly produced very dangerous consequences in the United States until peace was made at the national level, and spread over to the regional level in Canada, Mexico and parts of South America. However, that particular war, which involves boilers and pressure vessels, continues today at the Regional vs. International and Organizational levels.

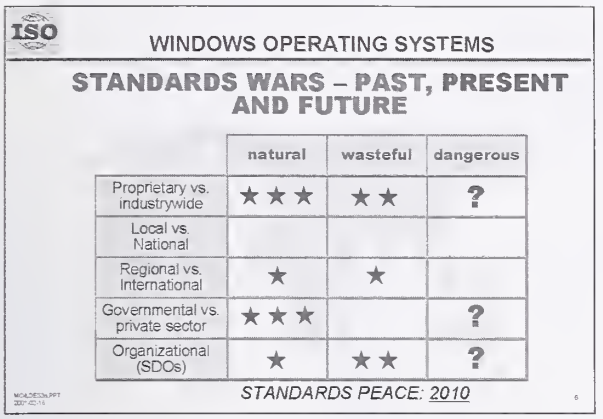
I am again quoting from Al Batik's book to set the scene: "Steam power was a great step forward for mankind. It is hard to believe, though, how little was understood of the destructive power of steam. In 1884, approximately 10,000 boiler explosions and failures occurred—property damage, fatalities and injuries must have been terrible. In contrast, in the period 1974 to 1984, there wasn't a single boiler explosion in the United States. What was the difference? It was the development and application of the ASME Boiler and Pressure Vessel Code."

However, if ASME's standards solved the problem at the national level so well that they have been successful in the Americas and other regions, there are rival European standards and, at the international level, there is no agreement. While you check out my analysis of the current state of this war, let me tell you that even though ISO/TC 11, *Boilers and pressure vessels,* was one of the first ISO technical committees, by the time it was established, many countries had already firmly established national standards for boilers and pressure vessels, complicated by the fact that these devices were also subject to national and local safety regulations. The result is that national delegations to ISO/TC 11 have stuck relentlessly to their positions and movement to developing International Standards has been hopelessly deadlocked.



GRID FOR BOILERS AND PRESSURE VESSELS

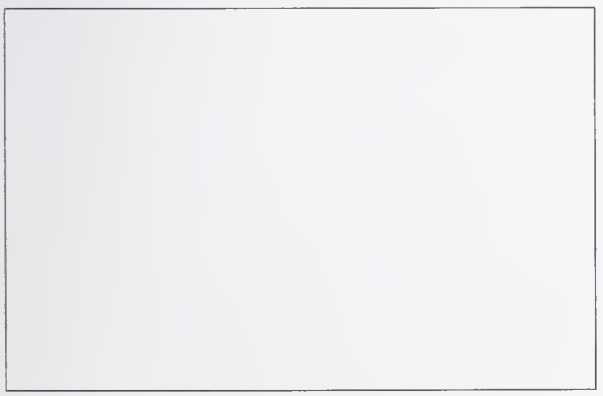
A way out of this impasse came with a proposal a couple of years ago to re-activate the committee in order to prepare an umbrella standard which would specify performance requirements for pressure equipment codes and standards that are in current use throughout the world. I greeted this development enthusiastically, because it seemed to me a means by which ISO could help to stabilize, contain, and acknowledge the realities of different, but equally good standards solutions existing in world trade, even though they may never be design compatible. I'm pleased to report that this work has advanced, thanks much to the work of ASME, and that ISO/DIS 16528, *Boilers and pressure vessels—International harmonization of codes and standards,* is now at draft International Standard stage in ISO.



GRID FOR WINDOWS OPERATING SYSTEM

My third example of a Standards War analysis is a topical one, the Windows operating system. You may or may not agree with where I have put the stars on this grid. However, whatever your views on Microsoft's alleged monopoly strategy, it must be evident that the company's successful Windows operating system, with 80+ % of world market share, has every reason to be considered as a de facto international standard.

Is this war over? Will we eventually see something that could be called a consensus based industrywide standard rather than a proprietary one? What are the downsides to the current state of affairs? Here, you see nearly all my stars in the Government vs. Private sector box. And, for a small additional fee, you can see Bill Gates' grid, as soon as, and if ever, he agrees to play the game.



GRID FOR BILL GATES

For those of you who would like to play Standards Wars, I'll be glad to let you have an electronic copy of my grid so you can locate your stars according to your own analyses of the examples I have given. Of course, you can also play with other Standards Wars. If time allowed, I'd like to play the metric system "SI" war game with you, or the field bus war in IEC, and there are many new wars coming up on the radar. Just to mention a few: the home wireless war between Home RF and Wi-Fi; the war for domination of the third-generation mobile telephone market between incompatible American, Japanese, and European standards; the continuing standards conflict over JAVA; the refrigeration technology war between hydrocarbon refrigerants vs. PFC's . . . , etc. etc. etc.

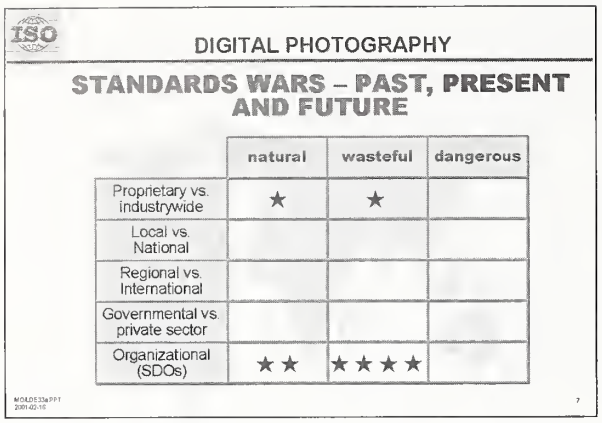
I could go on, but I want to make my point here that these wars paradoxically show the health and strength of the free enterprise system and also the standardization systems that support it.

I noted earlier that standardization is not the natural first reaction of market players. But some of it is, in one way or another, inevitable. It happens in coherent free markets when market players come to the conclusion that the free market diversity of specifications for market transactions has become too heavy to support and that a standards-based rationalization will bring benefits to all the market players.

When I speak about international standardization and coherent markets, I am referring to the myriad of business transactions which have become, or are on the way to becoming, truly global in character. Everyday, this list of truly global market sectors is growing—automotive, informational technology and telematics, pharmaceutical, medical devices, petroleum etc.. The trend is irreversible—no need to argue about it. Coherent global markets are already there, or very close to being there, in very many sectors and the market players eventually become insistent on rationalizing their business transaction processes with globally agreed standards.

The pertinent question is whether or not these global market players will turn to standards development organizations like those represented here today, or will they turn to consortia, or will they be content to let the market leaders dominate? We may not yet know the answer to this question from sector to sector, but it is clear that the major market players are not locked into the SDOs' way of doing things and that we offer only one possibility for supplying their standards' needs.

Market players who decide they need standards are not obliged to beat a path to the doors of any of the SDO's represented here today, and this brings me to the final grid in this demonstration. While it cites a specific case, "digital photography," it illustrates a general point on which you may have heard me harp several times before.



GRID FOR DIGITAL PHOTOGRAPHY

Here we see one of the classic cases in which the borderlines between two standards developing organizations, and the decisions as to which organization should be doing the standards work, has been so contentious as to cause the market players to pull their hair and consider abandoning both organizations. The organizations (very close to home) are ISO, where the classic photochemical technology and camera optics work has been done for donkey's years, and IEC, where electronics and digital media data processing have similar stong roots. This was a standards war of the most embarassing type, at least for me. As you can see, whenever I put a star in the organization combattant box, I automatically put two stars in the wasteful consequences box. We, as standards organizations, all of us, really do shoot ourselves in the foot when we allow these kinds of wars to drag on.

Here, at least, I believe we will have a happy ending. ISO and IEC decided, already in 1999, that disputes over allocation of standards development work between ISO and IEC Technnical Committees would not be allowed to continue, even if an arbitary decision as to who does what had to be taken at the level of Presidents and Vice Presidents. This was, in fact, the case for the digital photography conflict in 2000. Assuming the decision sticks, and we have every intention that it will, I identfy the "Standards Peace" date of 2002.

LDE AS JAMES BOND (again)

Now, in closing, let me apologize to anyone who might have felt offended by my rather "theatrical" use of the word wars. I only wanted to get your attention, and to show you why I have always found the standarization business to be so fascinating.

The Standards Wars that we SDO's might fight and witness may seem like petty affairs in comparison to real wars, or even to real life competition in the business environment. And, with all due respect to my SDO counterparts, I don't think any of us see ourselves as field marshals, master sergeants, or even undercover operatives like James Bond—but you never know!!

While standardization deserves to be taken seriously, maybe we sometimes take ourselves a little too seriously. Today, should not be that kind of a day.

Thank you for you kind attention.

21st Century Prospects

Mathias Fünfschilling
President, International Electrotechnical Commission

Two friends—a biologist and a toy maker—were lost in the Sahara and they were trudging along, desperately thirsty, when the biologist saw a peculiar object sticking out of the sand. "Look," he said, "a marine fossil: proof that this desert once used to be an ocean." The toy maker inspected the object and said: "That's not a fossil, it's a child's toy: proof that people might still live around here and water might be nearby." They debated for a while, then started to argue and finally came to blows.

Whatever your understanding of a thing, and whatever signification it may have for you, everything that you encounter in this world will force a response from you. You may choose to ignore it, to flee it, to own it, to destroy it, or to understand it, and so on and so on. Many, many responses are possible. The IEC is a thing in this world and its presence forces a response of some sort from industry, from governments, and from academia, as well as other players.

The USA took a leading role right at the very beginning of international electrotechnical standardization when the idea for the IEC originated in St. Louis, in 1904. The IEC was officially founded two years later, with the USA as one of the founding members. The aim then, as it is today, was to reach consensus on international standardization. At that time, electricity generated by human effort was new technology and part of the reasoning behind creating international standards was to help the new technology spread so that everyone in the world over could enjoy its benefits. When you read from that earlier time some of the declarations concerning the benefits to humankind that were to derive from the advance of science, the sentiment appears to be slightly naive: world peace and the end to hunger seemed to be just around the corner. Perhaps those sentiments appear naive because the promised benefits have not been delivered, or at least not yet delivered in full. Or maybe it's because we lived through some very difficult and very violent times in the 20th century that we see those pre-World War I sentiments as being slight naive. But if we listen carefully, we continue to hear the same ideas being expressed today. The expression may be less or more reserved, but no one doubts the idea that science will deliver on its promises, that it will deliver new developments destined to benefit humankind as a whole. There is much evidence in the world today that science and engineering are delivering on the promise. That's not to say there aren't mistakes and errors. Killer bees and mad cows are but two examples. But the really exceptional technological revolution that humans have witnessed from the late 19th century until today provides many, many examples of beneficial science.

I think we will all agree that this revolution involves a tremendous amount of sharing amongst different technological communities. Chemists share with biologists, who share with astronomists, and electrical engineers share with mechanical engineers, who share with civil engineers, and so forth. The technological revolution involves fusion and merging. If we take a telephone system as one example among many, we see the seamless fusion of electricity with other technologies. Just as technology merges, so the international standards development organizations—and with your consent I'll call them ISDOs just to make things easier for my tongue—so the ISDOs that prepare standards for that technology need to coordinate their efforts. Each ISDO has its field of work and I am not saying that one ISDO should try sowing its own seeds in someone else's field. But to make the telephone system, some coordination has to exist between those who know about electricity and those who know about mechanics: you have to lay cables, launch satellites, build microwave towers, and so on. To make standards for the telephone system as a unit, and not as a collection of separate systems, requires coordination between those who know about electrotechnical standards on one hand, and a variety of other kinds of standards on the other. That way, the system works as expected.

The market, and ultimately the consumer, will reject the notion of standards development organizations working in a purely independent manner exactly because the trend is towards merging and fusion and towards internationalization and globalization of trade. The market wants a one-stop shop for standards and certification. If the market is becoming, or is now global, and if the products and services within it are to be considered global, then the standards on which they are based should also be global. I wish to qualify that last statement. Not every single standard on this planet should be an international consensus-based standard and *only* an international consensus-based standard. The market will tell us what it wants, will tell us when it wants an international standard or when a national standard is sufficient. The important point is how we go about providing the market with international standards.

For many years now the IEC and its partner organizations, ISO and the ITU, have provided the means for every country in the world to participate actively in developing together global, consensus-based international standards.

The development process for international standards allows an essential level of consensus, a stable foundation on which to build an agreed route forward. Technical standards are voluntarily conceived, elaborated, adopted, and applied by users ranging all the way from individuals through companies, professional associations and national governments to regional groupings. They are democratically developed in the widest global perspective, aiming to offer the greatest good to the greatest number.

We are all aware that there is a very difficult trade-off to be made between speed and legitimacy: standards that are developed rapidly and that at the same time represent the voices of all players. The ideal is to have both in their fullest form, but we humans don't often get the chance to encounter the ideal in this world. Greater speed means fewer voices while more voices mean less speed. What to do? I think the point can be found here, in the USA. It can also be found in the United Kingdom, in Japan, in South Africa, in Brazil . . . In short, it can be found wherever you find democracy, and the United States is one of the greatest examples of a democratic system. Democracy takes time. Ensuring that everyone has the opportunity to have their say is the basic principle here in the United States, just as it is in the IEC. But that can't always be done quickly. The market wants things quickly, wants things immediately. Well, if we have to make the choice, which do we prefer? Speed of delivery, or that everyone has the opportunity to have their say? I'd like to see both, but I know I can't. So I'll choose democracy because there are times when we have to resist the tyranny of the market. There are times when we have to create structures and systems to make sure that everyone gets the chance to participate.

It's a tough, Darwinian world and survival of the fittest applies to creatures just as it applies to companies and organizations. Keep up or fall behind seems to be the rule. But the market isn't independent of us humans because we humans create the market. And if we create it, then we can also introduce structures and systems to influence it. With globalization, ISDOs will come under more and more pressure to survive in the Darwinian market. We will find ourselves confronted by political, economic and technological challenges at such places as the World Trade Organization. These challenges are very likely to have a profound impact on our work and this could be a negative impact if we don't prepare for it.

It is time now to prepare for the future that is to come. Rather than race blindly ahead, endlessly striving to try to stay ahead of the other carnivores in the pack, we need to call a halt to consolidate and regroup. All standards development organizations, whether national, regional or international, have one thing in common: we make standards for products, systems, and services. And we do so with the aim of providing a benefit to industry, to government and to the consumer. This commonality can serve as the basis for united strength and for transformation. We live in a world of change. Another word for change is adaptation, and that's what Darwin talked about. If we do not recognize the change that is going on around is, we won't be able to adapt to it. This will render us obsolete, perhaps ultimately even extinct.

In a world where trade is globalizing, where there is greater similarity amongst peoples and cultures, and where communications are both total and transparent, we need to sit down together. We need to sit down together, take stock of where we are, estimate where we think we're going, and find a solution that is appropriate to the challenges that face us. If we live in a world where trade is globalizing, then clearly, when it is appropriate, we need a global solution.

The IEC, ISO, and the ITU have taken initiatives that will lead to working more closely together. This will lead to a forum where we can coordinate efficiently our policies and politics for developing international, consensus-based standards. Together the three ISDOs cover a vast amount of technological territory. Only by working together can we ensure that we will meet the challenge of preparing standards for fast moving, merging technologies in a fast-paced, global market.

The United States was a founding member of the IEC, ISO, and the ITU. Traditionally the USA participates very actively at all levels in the three organizations. America is an especially important contributor to standardization in fields of emerging technology. The United States has the advantage of a giant domestic market and this market requires standards. So American industry develops standards for high tech and emerging technologies in the dynamic American market, and often enough these standards became the basis for subsequent international standardization work. American innovation is often the cutting edge for new technology, and the American economy, as the most powerful and dynamic of all economies, is the place where much technological leadership takes place.

If we are to address the fast-paced, globalizing, technological market in a way that is appropriate, how should we do it? A single, international platform, where all players, all industry and all consumers have their say

is the best way to go. It is the right structure within which everyone can contribute to create international, consensus-based standards. I am not suggesting that we create a new layer of government, or another bureaucracy in addition to what we already have. I do not suggest that because the elements already exist. All we need to do is rearrange their relationships in the right way, at the right time.

There is no doubt that the United States leads the world in many ways. Whether this is a responsibility you seek actively, or that is thrust upon you by circumstances, is a debate for another time and place. Today, I am suggesting that the USA has another opportunity to support an idea and take a leading role in it. Just as in 1904 you enjoyed a leadership role in helping to create the IEC, so today you have the opportunity to continue in that role by helping to create an international standardization effort that will coordinate the work of national, regional, and international SDOs. While we as engineers would perhaps like to devote ourselves entirely to the practical aspects of preparing standards for technology, while we would like to focus on amperes and watts and nanoseconds and tensile strength and a hundred other variables, unfortunately the politics of standardization has a way of intruding on our world. The world will not let us ignore non-engineering and non-scientific issues. So let us address them also and find the common ground where we can concentrate on important issues together. Let us take our guidance from the market itself, which is telling us that globalization is the future. That being the case, a globalized response seems to be the right thing when it is appropriate. We can see the need for this and we now have the opportunity for it. Let's do the right thing . . . together.

We are here today to celebrate 100 years of work, 100 years of effort, 100 years of history. I speak for the entire IEC family when I say that I am proud to be invited here to congratulate the National Institute of Standards and Technology on its 100th anniversary. Being around for 100 years and remaining a valid contributor throughout that period are admirable achievements and proof that, in this Darwinian world, you have known how to survive and adapt.

Now, let us return to the biologist and the toy maker that I mentioned at the beginning. We left them fighting over the signification of the object they found in the sand. Well, months later a solitary traveler on a camel passing by on his way home from a long journey came across two skeletons lying at the base of a dune, bony hands clutching each other's bony throats, and between them he saw something familiar. He got off his camel, knelt down and picked it up with a happy smile and said: "I'd wondered where I'd lost my prayer beads."

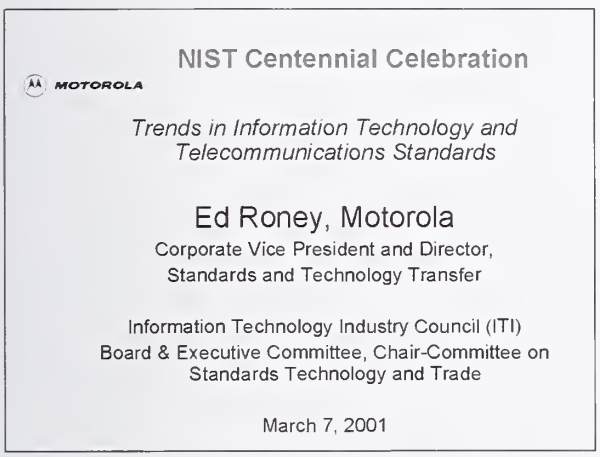
Thank you for listening.

Information Technology

Trends in Information Technology and Telecommunications Standards

Ed Roney
Corporate Vice President & Director of Standards and Technology Transfer, Motorola

It is a pleasure to be here. Looking out at this audience reminds me of a study conducted by a prestigious eastern university some years ago on people who attend conferences and seminars. The study showed that 20 percent of the audience typically paid very close attention to the speech, took in every word, compared it against their life experiences, and got a lot out of it. Another 30 percent are in and out, and pay attention to part of it. Fully 50 percent don't pay attention at all, and the study further showed that they are day dreaming. So I take some comfort in that study because I know when I finish that at least half of you will be happy.

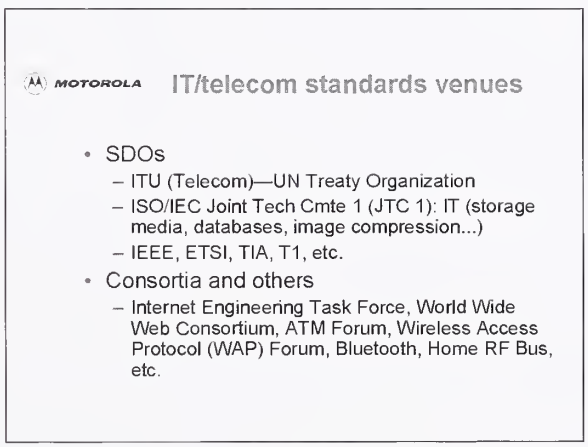


SLIDE 1

Good Morning. I have been asked to speak about current trends in information technology and telecommunications standards.

SLIDE 2

There are some really dramatic changes underway. If you go back 20 years ago, for most U.S. companies—and I know for Motorola, the vast majority of the market was in the United States. Today that has changed dramatically, with well over 50 % outside the United States, for Motorola and for other companies. Global markets are clearly the focus for today's hi-tech companies as the last two speakers clearly said. Needless to say, hi-tech companies need global standards more than they ever have before. Let's look at the standards venues in information technology and telecommunications. There are two basic categories.



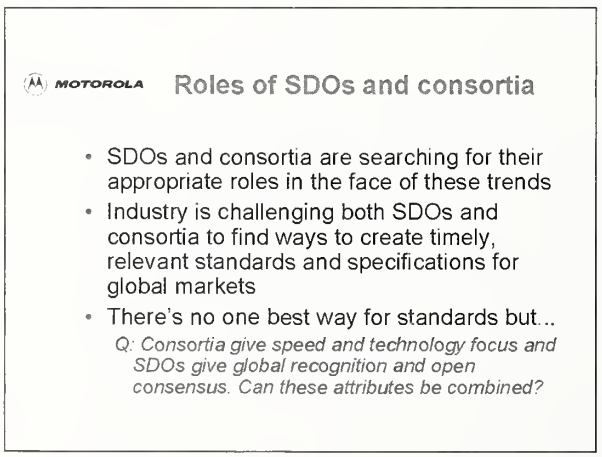
SLIDE 3

One category is that of the traditional standards development organizations. In the United States, these are the ANSI accredited SDOs. The other category is the consortia and partnership projects. Actually the partnership projects can be between these two, because they are partnerships among the SDOs. Slide 3 gives some examples of standards organizations in both of those categories.

Looking at industry trends, there are some fundamental changes underway now that have been underway for 5 to 10 years. If you look at these trends, globalization, as I have already mentioned, is a very, very important trend. Another important trend is convergence of the various industries—information technology, telecommunications, automobile, and consumer products—which are all coming together. These industries handle standards in various ways. It is interesting to watch the dynamics that play as this happens. Still another trend is the speed of technology development. Introduction of

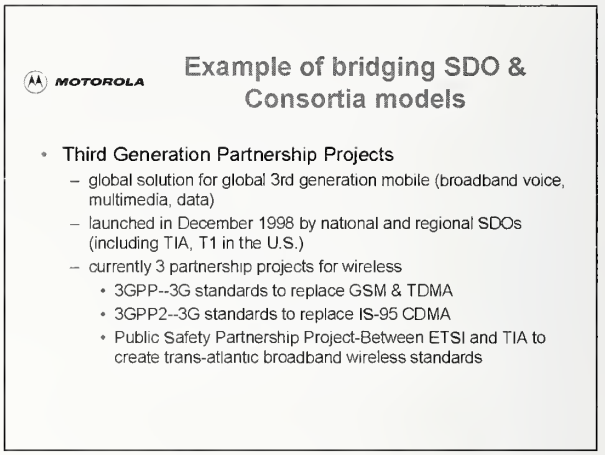
SLIDE 4

new products is much faster than it has ever been in the past, and it is going to continue in that direction. Research and development is done on a faster time scale, with more collaboration between companies, and companies and governments, so intellectual property rights, and the complex rules that apply to standards organizations are important. Ten years or so ago there were a lot of problems with them, but I think they have been pretty much resolved so that everyone is reasonably comfortable with the rules for Intellectual Property Rights. Of course, narrow profit margins are another concern. I can tell you that this year, in 2001, that is really true. Profit margins are going to zero, and in some cases, negative.



SLIDE 5

As we look at the standards development organizations and consortia, we see that they are searching for their proper role in the face of these trends, with these dramatic changes underway. Companies and industry are challenging both of them to find ways to create timely and relevant standards for global markets. There is not one best way in every situation to develop standards. Consortia tend to give speed and a technology focus, while the standards development organizations give global recognition and open consensus. A question that one might ask is if these attributes can be combined.



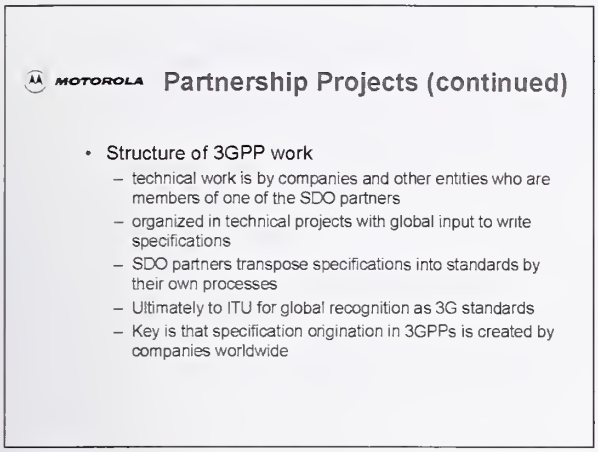
SLIDE 6

Perhaps the biggest change underway in the last couple of years is the paradigm of partnership projects that has occurred in the wireless telecommunications arena. For example, I am Chair of the ANSI telecommunications standards committee that was formed to engage with ETSI, European Telecommunications Standard Institute, as well as with the Japanese, Chinese, Koreans, et cetera, to develop these global partnership projects. I led a group of U.S. companies around the world meeting with these other organizations. This was an initiative created by the Europeans, by ETSI. It was a very good one.

Let's take a look at what this new paradigm is all about. First, it is a consortium that is created by the standards development organizations. In the case of the third generation wireless partnership projects, the Telecommunications Industry Association (TIA) and Committee (TIAC) are very actively involved in the process for the United States. The projects are global to produce specifications for third generation mobile standards. Launched a little over two years ago, there are currently three partnership projects for wireless.

There is a second partnership project—I will call it cellular partnership projects for third generation cellular standards. So all these competing standards you hear about are really coming down to two; one for wireless and one for cellular.

Then there is a new partnership project that has just been formed which has been in the news recently. The goal of the Public Safety Partnership Project between



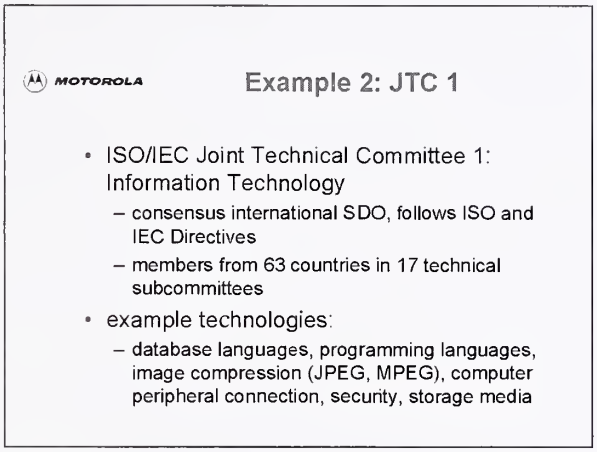
SLIDE 7

ETSA and TIA here in the United States, is to create transatlantic broadband wireless standards. This project is particularly noteworthy because just this week there was a shooting in California, and several years ago there was a shooting in Colorado, Columbine High School. It came to light after all the smoke cleared that the public safety organizations that showed up at the scene could not communicate with one another. They had to send hand signals of all things! The reason was that some of them were using the U.S. standard for their equipment, and others were using the European standard for their equipment. So this public safety partnership project came about as a partnership between Europe and the United States. In fact, the European Commission is funding part of this, and we are working to see if we can get the U.S. government to participate as well on this issue. This partnership is important because many of the players in the standardization process are police chiefs and fire chiefs from small communities that don't have budgets to travel around the United States, much less to Europe, to work on standards.

The structure of the partnership project involves basically bringing together the engineers from companies throughout the world that have an interest in the subject. In the telecommunications arena, it would be the operators, such as Korea Telecom, and Nippon Telephone and Telegraph, and so on, and the equipment manufacturers, such as my company. They meet at different places around the world. If you leave engineers alone, and get the lawyers and the politicians out of the way, these engineers will create some very good specifications that customers can use to procure equipment.

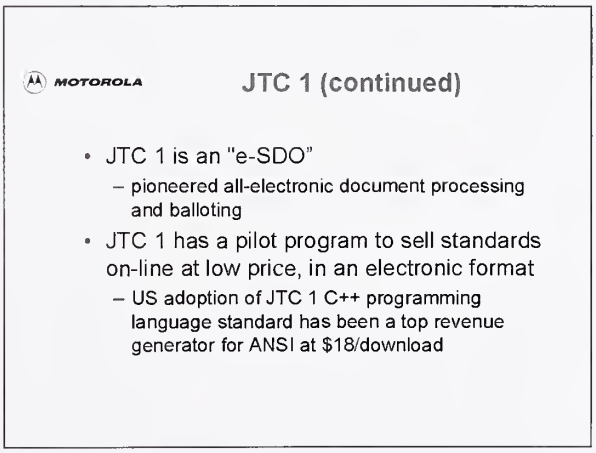
Once created, these specifications go to the regional standards development organizations such as, for example, TIA in the United States, and are issued as their standards. From there, they go into the ITU, the International Telecommunications Union, to become global standards. The procurement process can begin very early, just as soon as the specifications are ready, or even almost ready.

I was in Switzerland last week in a meeting with 30 or so telecommunications companies, and it is pretty much unanimous, and I didn't hear any dissent from the view that these partnership projects are really working well.



SLIDE 8

Another example of this new paradigm is the JTC-1, the Joint Technical Committee Information Technology area, which is a joint committee between ISO and IEC, which creates global standards, of course. It produces standards that are very important to the IT and the telecommunications industries such as the MPEG and JPEG impression standards.



SLIDE 9

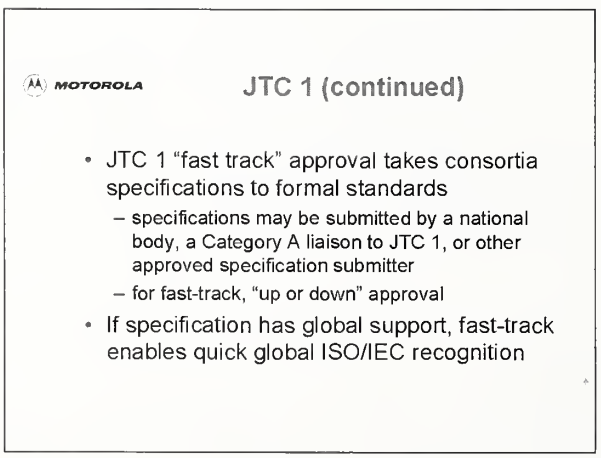
JTC-1 is truly an electronic SDO. It has pioneered all electronic document processing and balloting. Beyond

that, it uses hi-tech apparatus such that standards are now developed by using wireless Local Area Networks (LANs). All the engineers come to the meetings with their lap-top computers and communicate right there during the meeting using the LAN as well as conventional communication. Communication is about a 11 megabyte per second data rate inside the room with a direct connection to the Internet so that they can go back to the server on their corporate networks to get information. This really speeds up the standardization process. In this way, you have all the information that you could ever hope to have at your fingertips, with a very fast downloading of the information.

Another aspect of the changing face of standardization is in the sale of standards. For example, JTC-1 has a pilot program to sell standards on-line at low prices in an electronic format. The example given on Slide 9 is the C++ programming language, which is an electronically available standard. This approach is really important because virtually every company that I have talked to believes that most of the costs that goes into creating standards is the time of our engineers. The time for the ones that travel to the standards meetings, as well as for the ones that don't travel, but produce the documents that go into standards is the lion's share of the costs of standardization.

Once the standards are created, we would like to see them promulgated as widely as possible, free on the Internet. We think that is the right way to do it. This isn't quite free, but it certainly is a step in the right direction. The other thing that I would say is that if you look at the resources that hi-tech companies are putting into standards, and that is the engineers, over the last 10 years, there has been a massive migration away from the traditionalist SDOs over to consortia and partnership projects. One of the things that we look at is can the standards, once they are produced, be easily obtained free on the Internet as the best way forward? Of course, I should hasten to add that, as I look around the room, some of my friends from SDOs are saying, well, how are we going to fund this?

Of course, the companies have got to come up with another source of funding if we are going to have standards free on the Internet. The JTC-1 has—and cycle time being very important—a fast track approval process that beats the cycle time requirements of industry. Any number of entities that are shown on the slide can submit the specifications into this process. This provides timely standards, and is really a good model.



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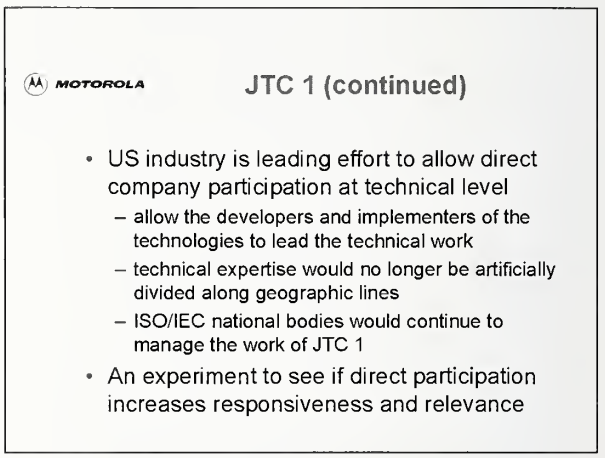
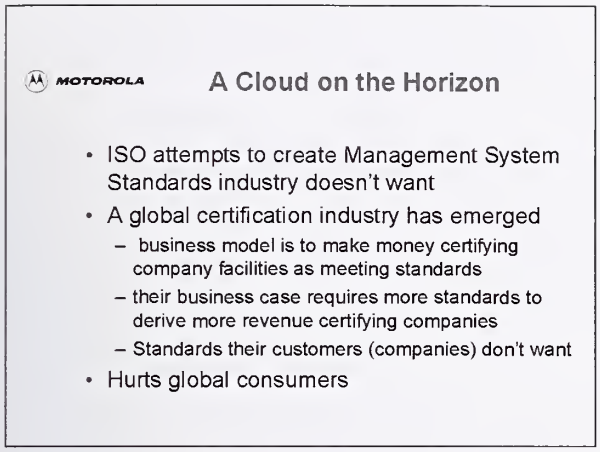


SLIDE 11

The U.S. industry is leading an effort to allow direct company participation at the technical level. This is bringing the IT paradigm for new processes and creating standards very close to the one for the telecommunications partnership projects—the one that is working so well. This allows the people developing the standards to work together in doing the technical work, so that technical expertise would no longer be artificially divided along geographic lines. The ISO-IEC national bodies would continue to manage the work of JTC-1. This is an experiment at this point to see how it works. I predict based on the partnership project model and telecommunications that you are going to find that it works really well.

With all of this really good work that ISO is doing, there is a cloud on the horizon that I thought that I ought to mention here today, and that is management system standards. I guess we have had two of them, ISO-9000 and ISO-14000. When ISO-9000 came out, a number of companies came to the conclusion that it didn't add any value. Motorola came to that same conclusion. We were using the Malcolm Baldrige process and 6 sigma, and we found that if you met ISO-9000 that you were only

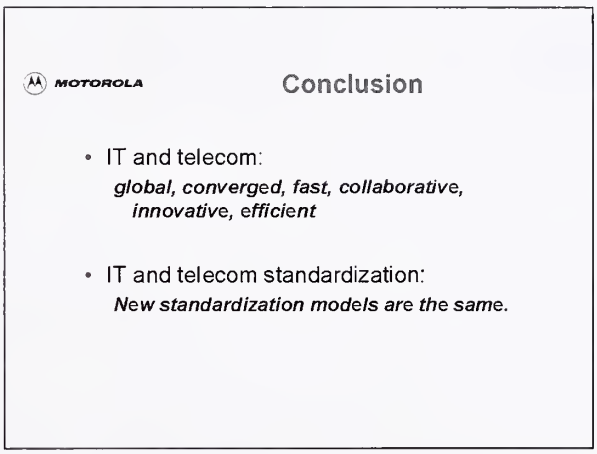


SLIDE 12

at say, 3 sigma or 4 sigma. It was actually causing problems with suppliers who said, gee, we meet the global standard, and why do we have to get any better? Well, if you want to supply components to our company, you are going to have to get a lot better. It really was very expensive to have our facilities certified, and you had to become certified because European customers were putting clauses in their contracts that you had to be. They required that your facilities had to be certified ISO-9000 or you couldn't bid on the contracts. It became an absolute requirement with a number of companies having exactly the same experience.

Then several years ago there was an effort to create a new management system standard on occupational health and safety. Well, this brought European and U.S. industry together. It was nearly unanimous. Almost all the companies on both sides of the ocean felt the same way about this; that there was yet another one of these standards that was going to be expensive and would not add any value. We have heard stories of a number of ideas for management system standards coming along. We concluded that what is going on here is that there is an industry that has been created, launched out of ISO-9000, to certify companies' facilities, and make a lot of money doing that. A good businessman will look for new products and new opportunities, and those new products of course are new management system standards that we don't really need.

Now, I am not up here—and I hope that you don't take me as doing this—throwing stones at management system standards, because there are some good ones. For example, the automobile industry has a quality standard, QS-9000, and the telecommunications ndustry has another one. Motorola and other companies worked very closely with these industries in helping to develop those standards. But those are standards that the customers—that the automobile industry, that the telecommunications industry – say they need. That is great, and that is fine. What I am talking about here are standards that you can't find anybody in the industry that wants them, except the industry that makes money certifying facilities. That's not a good model, and it hurts global consumers.



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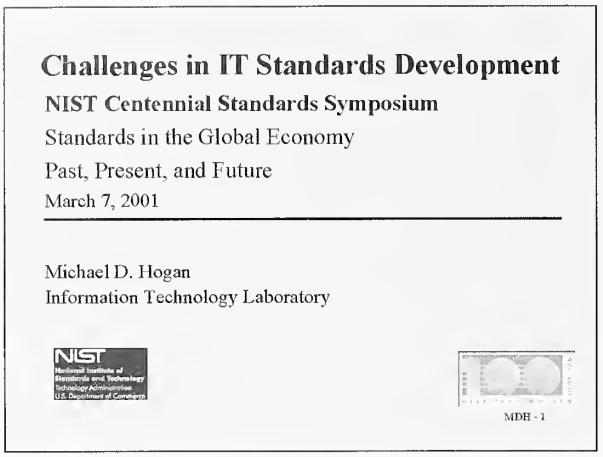
In conclusion, in the information technology and telecommunications fields, the changes are providing standardization that is global, and it has converged across these various industries. The resulting standards are very good on cycle time, collaborative, and innovative, and the processes are efficient. So the standards approach is working pretty well. If you compare information technology and telecommunications, the models are very similar.

I described the partnership projects for telecommunications and the experiment in JTC-1 because they look to me like they are just exactly the right paradigm to give industry what it needs; a timely, global standards.

Thank you.

Challenges in IT Standards Development

Michael Hogan
Standards Liaison, National Institute of Standards and Technology

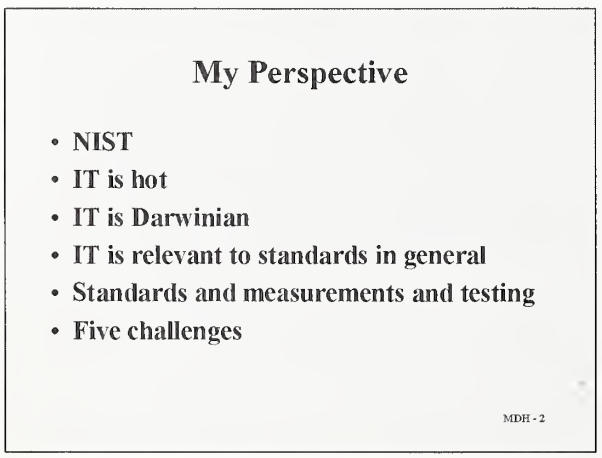


SLIDE 1

I am very happy to be here this morning and have the opportunity to talk about challenges in IT standards development. The NIST Centennial is certainly an appropriate time and venue to reflect upon IT standards, past, present, and future.

In just the last 10 years, IT has transformed the way people work, learn, and communicate with each other. While information technology promises to continue to improve our lives, the full potential benefits of IT will not be realized without a solid foundation of standards, measurements, and testing. This is a business necessity for both the United States and the world.

Slide 2 will give you a bit of a perspective, because I want you to know how emotionally involved we are at NIST with this subject.



SLIDE 2

My perspective starts with NIST. NIST has been involved with building and using computers for over 50 years, and with developing computer standards for more than 30 years. I myself have been working at NIST for over 25 years, and some of my colleagues have worked at NIST for over 30 years, and some for even over 50 years. For many of us working at NIST, it is the best job that we ever had, and for some of us it is the only job. As rewarding as the work has been, the people that I have worked with from government, industry, and academia have been the greatest rewards for me.

While my remarks are about technical and management challenges, and not about people, one former colleague is germane to this discussion, Jim Burrows. From 1979 to 1995, Jim served at NIST as Director of the Institute for Computer Sciences and Technology, which later became the Computer Systems Laboratory. This was a great time to be involved in the IT standards business at NIST. Jim was not only in the right place at the right time, but he was the right person. He was highly respected inside and outside of NIST.

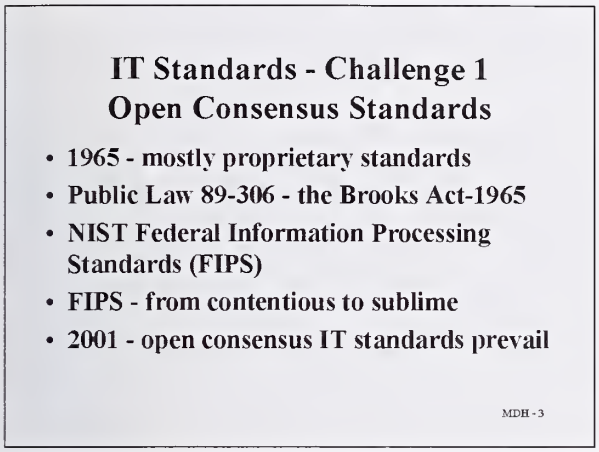
And now I would like to share a few words on my views of IT. IT is hot, and like many other things discussed today, IT is Darwinian, both for vendors and users. But I think it is truly Darwinian in a different way. It is about survival of the fittest, and unfortunately the rules for fittest keep changing over the years. The improvements in price performance for IT are unmatched by other industrial sectors. Information appliances and services are increasingly ubiquitous, and they are the great enablers of the productivity gains in other sectors of the economy.

To put IT innovation in perspective for you, let me compare the automobile industry to the IT industry. If the automobile industry was like the IT industry over the last 30 years:

1. Today your automobile would cost mere pennies to own and operate.
2. Today your automobile would travel at hundreds or thousands of kilometers per hour on high-speed networks, even at rush hour.
3. Once a year, today's automobile would blow up, killing everyone inside.

While my remarks are IT centric, I believe that they apply to standards in general. And, you cannot meaningfully talk about IT standards without also discussing IT measurements and testing.

I will discuss five challenges from past, to present, to future, and to some extent all interrelated.



SLIDE 3

Challenge One. Open Consensus Standards.

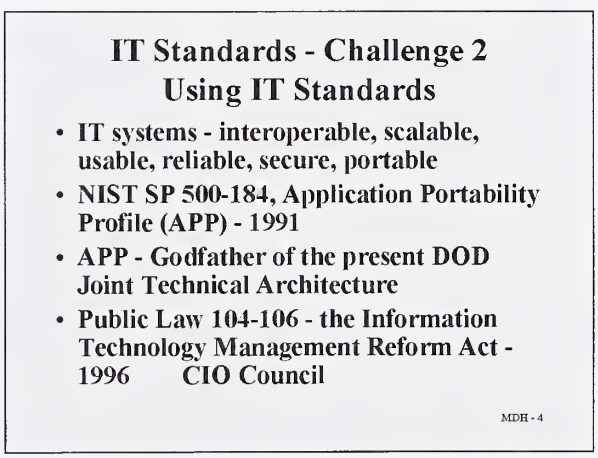
In the United States in 1965, the computer industry was based mostly on proprietary standards. So was what we now call POTS, the plain old telephone service. It was a very different world in 1965 from today, with no Internet and no World Wide Web.

The Brooks Act of 1965 was the Federal Government's response to avoid being locked in to buying proprietary, and expensive, computers. Under the Brooks Act, NIST was tasked with promulgating for Federal Government use, mandatory Federal Information Processing Standards, or FIPS, which were to be based upon open consensus standards. For over 25 years the, FIPS program was often quite adversarial, pitting some IT vendors against IT users. It was an exciting era. NIST was making history with its FIPS program. When Jim Burrows arrived in 1979, he found us very arrogant in our thinking; that such a small group at NIST could change the IT world. Ironically, being arrogant, we thought that Jim was just praising us.

Overall, the FIPS program has gone from contentious to sublime. I will review a few FIPS to show what has happened over the years:

1. FIPS 1 was approved in 1968. It was for ASCII. There was opposition from vendors. They saw compliance costs and no additional profit. They were right.
2. FIPS 21, was approved in 1972. It was for COBOL. There was opposition from vendors. They saw compliance costs and no additional profit. They were right.
3. Vendors' ire at NIST probably peaked with FIPS 60 in 1979. It was for the I/O Channel Interface. Now some vendors saw their entire business models for profitability threatened. Indeed, four computer vendors sued the U.S. Government to stop the implementation of FIPS-60. They lost. And they were right. It did threaten their profitability and their existence.
4. By 1987, we were starting to put out a different category of standards, like FIPS-127, Database Language SQL. Here the vendors were writing the standards along with the users, and the vendors had hopes, dreams, and aspirations of profiting from these open system standards. There had begun to be a sea-change somewhere along the line, between open systems as a threat to business models, to open systems as an inevitable cost of doing business in the changing world of IT.
5. Now in 2001, we have proposed a FIPS for the Advanced Encryption Standard (AES), and that has been greeted with enthusiasm from all corners, both users and vendors.

In 2001, open consensus IT standards prevail. But the need for more FIPS has largely gone. FIPS made history and became history.



SLIDE 4

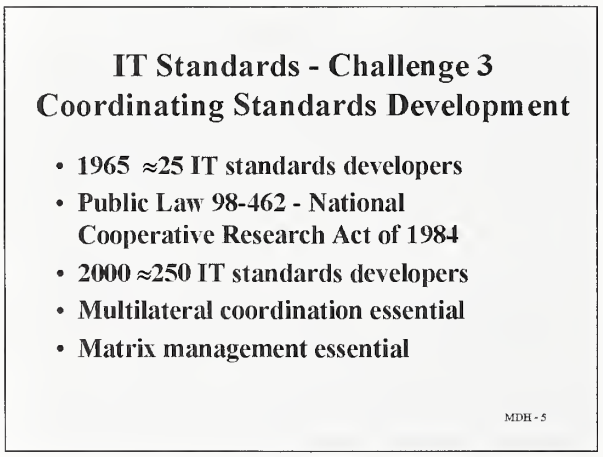
Challenge Two. Using IT Standards.

About 1990, Jim Burrows challenged his division chiefs to assist Federal Agencies in using open standards for their acquisitions, their near-term acquisitions. IT users were seeking to procure IT systems that were interoperable, scalable, usable, reliable, secure, and

portable. (They still are!) And they were beginning to see a bewildering array of IT standards from which to choose. This task was not nearly as much fun as developing FIPS. There was, and is, a thin line between deploying leading-edge technology and deploying bleeding-edge technology.

NIST did develop recommendations on specifications and standards to use in defining an Open Systems Environment (OSE). Our first publication in this series was NIST Special Publication 500-184, Application Portability Profile, in 1991. This series of publications were the godfather of the present DoD Joint Technical Architecture.

In 1996, the Information Technology Management Reform Act took NIST off the hook. It led to the Federal government forming a Chief Information Officer (CIO) council, and appointing Chief Information Officers throughout the agencies, with the task of wrestling with standards based deployment of IT systems.

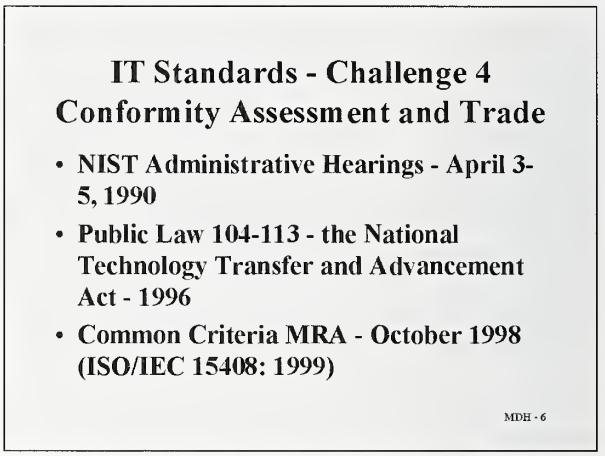


SLIDE 5

Challenge Three. Coordinating Standards Development.

In 1965, there were about 25 standards developers worldwide, wrestling with what we now call IT standards. In 1984, a law was passed that dramatically changed things for IT standards development in ways not foreseen. The National Cooperative Research Act was intended to promote research and development, and to amend the anti-trust, patent, and copyright laws in this country. This law, and its subsequent amendments, permitted IT vendors and others to form consortia that could jointly develop IT standards and specifications.

Now there are about 250 IT standards developers worldwide, about 10 times as many as in 1965. The 250 IT standards developers worldwide are not likely to go away anytime soon. Even if they did, the thousands of interdependent standards activities that they have underway would remain. Trying to make sense and use of these IT standards is increasingly difficult and increasingly necessary. Consequently, multilateral coordination among IT standards developers is now essential. Matrix management across IT standards developers is also now essential.



SLIDE 6

Challenge Four. Conformity Assessment and Trade.

NIST's role in national and international harmonization of conformity assessment has increased significantly over the last few years. By 1990, NIST had in place a growing number of testing activities in support of its FIPS program. So those of us involved in IT standards at NIST were very interested in the NIST administrative hearings held in April of 1990.

These hearings were intended to cover U.S. standards and conformity assessment practices that effect the acceptance of U.S. products in foreign markets. The hearings became a referendum on the state of the present U.S. standards system. It was overwhelmingly affirmed that the U.S. standards system was just fine. However, the furor over standards left little time to focus on conformity assessment and trade. But I believe that it cast the dye that this was now a top-down business issue for U.S. industry.

In 1996 the National Technology Transfer and Advancement Act tasked NIST with, among other things, developing a national infrastructure for laboratory accreditation. The recent MOU between NIST and the National Cooperation for Laboratory Accreditation (NACLA) is a real milestone in the development of a national system for laboratory accreditation.

Meanwhile, in the IT arena, NIST and NSA championed the Common Criteria MRA of 1998. This has started an international harmonization process in support of conformity assessment for ISO/IEC

15408:1999, Common Criteria for Information Technology Security Evaluation. The NIST National Voluntary Laboratory Accreditation Program has now accredited six laboratories for Common Criteria testing, and the results of this testing program are now accepted by government agencies in 14 countries.

I have saved my best for last.

IT Standards - Challenge 5
Software

- **Software is an intellectual creation**
- **"Nation needs software that is far more usable, reliable, and powerful than what is being produced today" (PITAC 1999)**
- **"measurement is one of the biggest obstacles now facing the software industry" (Capers Jones, Sci. Am., 1998)**
- **Sound software standards depend upon sound measurement standards**

MDH - 7

SLIDE 7

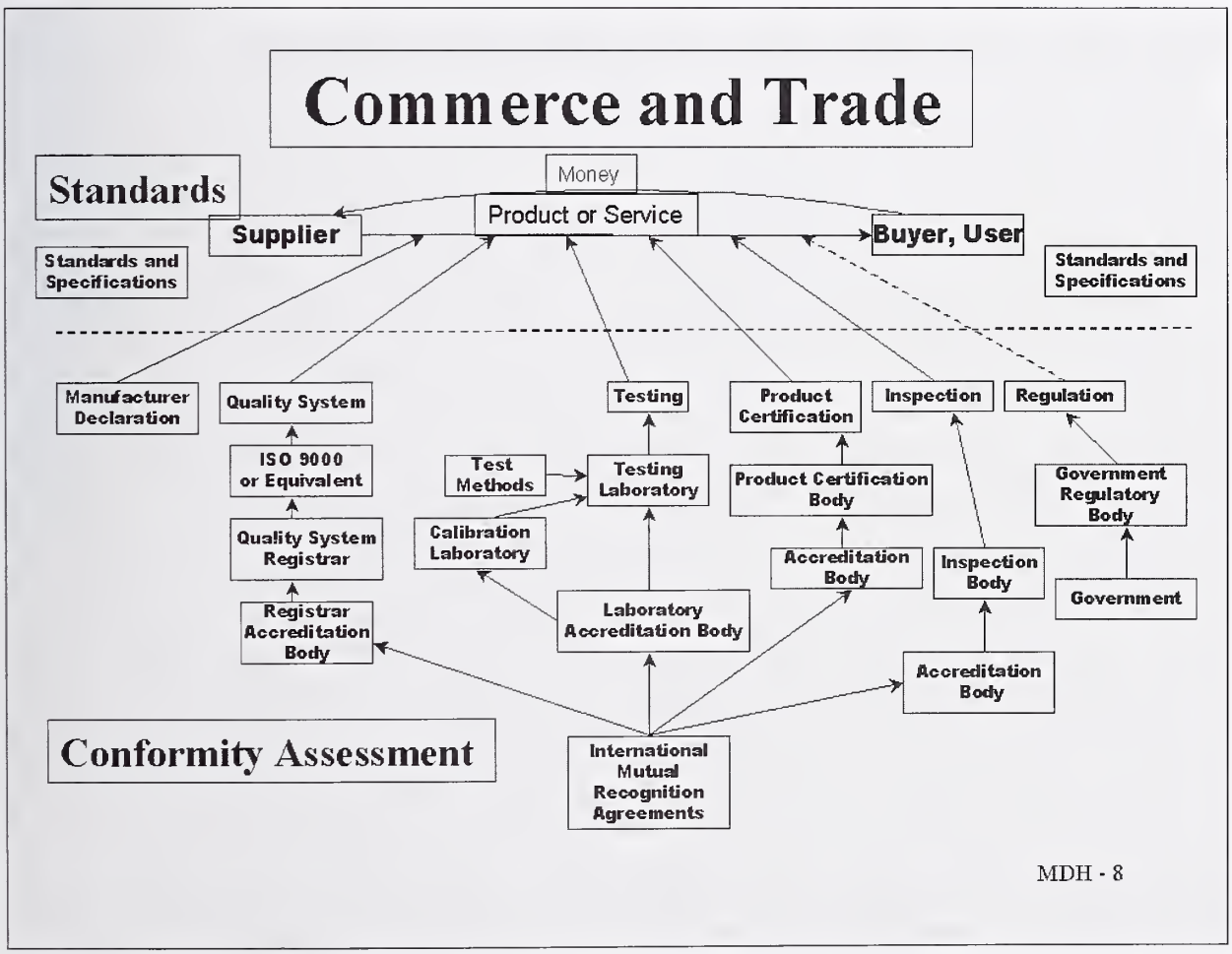
Challenge Five. Software.

Software is an intellectual creation that is independent of the medium on which it is recorded. Software is easy to manufacture. In other words, it is just a replication of a digital file. Software is difficult to develop.

In 1999, the President's IT Advisory Committee's (PITAC) Report, Investing in Our Future, listed software as its first concern for research, "the nation needs software that is far more usable, reliable, and powerful than what is being produced today."

In a seminal article on software metrics by Capers Jones, *Sizing Up Software*, Scientific American, 1998, the case was made that "measurement is one of the biggest obstacles now facing the software industry."

Sound software and software standards depend upon sound measurement standards. The physical metrology principles of unit, scale, and uncertainty presently have no counterpart in software metrics. The lack of software metrics affects virtually everyone because software is now used by almost everyone.



SLIDE 8

While software testing as a profession has certainly progressed over the last decade, the software testing researcher has been unable to fulfill the present needs of the software testing practitioner. In 1999, NIST initiated a study on the economic impacts of an inadequate infrastructure for software testing. The scope of this study was expanded in 2000, and the final report should be available sometime in 2001. Identifying economic impacts should help to identify, quantify, and focus research priorities for software testing.

Functional Model.

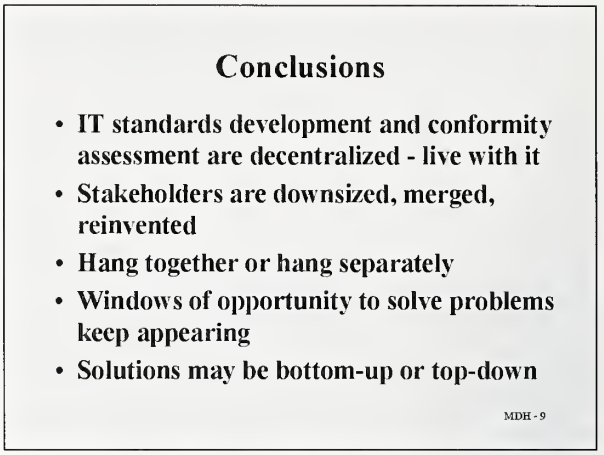
Don't try to take notes. This is not on the quiz.

All of the issues that I have discussed relate to the following functional model. Jeffrey Horlick, my colleague at NIST, has created this functional model of standards, conformity assessment, and testing. I have inserted it (here) as Slide 8 just to slam home my conclusions, which are mercifully brief.

Conclusions.

IT standards development and conformity assessment are decentralized. Live with it. Stakeholders have been downsized, merged, and reinvented, often more than once. There are scarce resources among stakeholders to cope with the ongoing torrent of IT standards, measurement, and testing activities. You can try for a competitive advantage by working alone. But often it is in your best interests to hang together or you will all hang separately. Don't lament what might have been. Windows of opportunity to solve problems keep appearing. Recognize and react. Solutions may be bottom-up or top-down.

Thank you.



SLIDE 9

Semiconductors and Optical Sensing

Semiconductor Technology: The Infrastructure That Lies Beneath

Robert I. Scace
Klaros Corporation
Former Director, National Semiconductor Metrology Program, National Institute of Standards and Technology

Electronics and semiconductors

Last year the global electronics industry produced over $1.1 trillion ($1.1 million million) worth of products, three percent of the gross world product. Electronics was two percent of the world product 12 years ago, and is forecast to reach four percent in only four more years. This accelerating growth reflects the widespread belief that electronics brings value to productivity, communication, health care, and many other positive aspects of life.

Almost without exception, electronic products require semiconductor devices to provide their brains and muscle. Fifty years ago, in 1952, only $19 million worth of semiconductor devices were sold. These went mostly to development programs that could pay their necessarily high prices. Few appeared in consumer products. Last year, $200 billion worth of semiconductors were used to build the world's electronics, ten thousand times the market value in 1952. Furthermore, today's microcircuits each have about 100 million times the functional performance of the first micro-devices in the mid-1960's. Each transistor in the first microcircuits cost well over $1. A dollar today buys a million transistors.

The transistor has wrought more change in 50 years than any other innovation in history. The rapid development of semiconductor technology and the remarkable reductions in cost per function of complex microcircuits worked quickly to replace vacuum-tube technology. These made possible the creation of many uses for electronics that could not be foreseen in 1952.

Standards for completed semiconductor devices

Standard specifications for physical configurations of semiconductor devices such as individual transistors and higher-power devices originally were developed by the EIA.[1] Internationally, IEC[2] Committee TC-47 on Semiconductor Devices developed standards, principally for finished products but also for tests on finished but unpackaged chips. Present-day microelectronic devices are so often designed for specific and rapidly changing applications that standards for physical configurations now have limited value.

[1] (U.S.) Electronic Industries Association, now the Electronic Industries Alliance.
[2] International Electrotechnical Commission.

Standards for the manufacture of semiconductor devices

However, standards are essential for the materials, processes, and equipment used to make integrated circuits and other semiconductors. These items comprise the manufacturing infrastructure for semiconductor devices of all types, regardless of their application. Manufacturing equipment and consumable materials are made in most industrialized nations and sold throughout the world. Global sales were valued at $63 billion in 2000, a third of that of the semiconductor device industry. The significance of this sector is greater than one would suppose, because the process technology for device manufacturing is integral to the tools and the materials provided by this infrastructure, and thus is provided by the supplier, not the user.

Historical background

Test method standards for materials required in transistor manufacturing, developed by ASTM[3] Committee F-1 on Electronics, first appeared in 1958, the same year as the initial standards for external dimensions and electrical connections of transistors were published by JEDEC.[4] NBS was actively involved in both organizations. NBS development programs had existed for many years in vacuum-tube metrology. New work was started in metrology for semiconductor materials and devices to support the work of both JEDEC and ASTM. As vacuum tubes were supplanted by transistors, the content of the NBS programs changed as well. NBS and NIST staff members have been continuously active in ASTM and JEDEC in both technical and leadership roles. At the invitation of the DIN,[5] a NIST staff member provides liaison between the relevant ASTM and DIN committees. NIST staff also have contributed significantly to the SEMI[6] standards program described below.

[3] American Society for Testing and Materials.
[4] Initially the Joint Electron Device Engineering Council of the EIA and the (U.S.) National Electrical Manufacturers Association. Now the JEDEC Solid State Technology Association, a member of the EIA.
[5] Deutsches Institut fNr Normung (German Standards Institute).
[6] Semiconductor Equipment and Materials International. Prior to 1988, Semiconductor Equipment and Materials Institute. Founded 1970 as a U.S. industry association. Began its standards development program in 1973. Standards work was extended to both Europe and Japan in 1986.

By these means, the standards produced by these organizations benefit by incorporating NIST's metrological developments. In return, NIST gains a better understanding of the industry's needs from long-term contact with the industry experts on these committees. NIST's cooperative involvement in transnational standards activities also helps to avoid differences in standards that might become non-tariff barriers to trade.

By the late 1980s, the technology used by the semiconductor industries included many topics outside the expertise existing in NIST's semiconductor metrology program. An Office of Microelectronics Programs was established to plan and support new metrology development projects wherever in NIST the necessary skills existed. The National Semiconductor Metrology Program that evolved serves not only as a funding and project oversight activity, but as an entry point for use by the industry in contacting NIST experts, as a resource for NIST staff in locating industry peers, and as the focus for NIST's participation in SIA Roadmap development and in the standards activities mentioned earlier.

Global operations require global standards

As the semiconductor device, manufacturing equipment, and materials industries grew, they established manufacturing operations outside their home countries. This development was principally driven by the need to manufacture in locations near foreign customers, to allow more timely response to their needs.

This move to global operation resulted in the major (and many smaller) suppliers of devices, materials, and equipment having manufacturing operations in every significant customer area: Europe, North America, Japan, and Southeast Asia. Supplier firms prefer to make the identical products for all their customers. Customers, which are also global, prefer to have their suppliers provide identical products to all of their locations. These mutually reinforcing preferences lead naturally to a need for standards that are equally global.

Such standards must be created by global consensus to be acceptable for global use. In general, nationally-based standards have failed to be widely accepted, in part because potential users of the standards in other countries perceive them as serving national purposes inconsistent with the interests of a global industry.

The principal exceptions have been standard test methods. These are usually developed by small regional groups of experts. Direct global participation is difficult to establish and maintain. The most successful producers of test methods for semiconductor manufacturing have been ASTM, DIN, and JEITA.[7] These groups maintain close coordination in the semiconductor field, which mitigates to some extent their national nature. Until recently, most of the standards from DIN and JEITA were published only in German or Japanese. Nearly all DIN semiconductor test methods are now published in English as well as in German, and JEITA produces English versions of their test methods whenever they are revised. The technical excellence of these standards has given them global acceptance, in spite of the lack of significant global participation in their development.

Timing requirements for microelectronics

Since 1991, the SIA[8] has developed and published a series of consensus-based, long-range, technological forecasts that reflect historical trends in the microelectronics industry and project anticipated needs for manufacturing technology 15 years into the future. In 1997, participation in this process was extended to European, Japanese, Korean, and Taiwanese industry associations as well. This collaboration produced the 1999 International Technology Roadmap for Semiconductors, a global technological consensus. A new edition will appear late this year. The 2001 edition will define the technology expected to be required for new microelectronics generations, each providing a four-fold increase in performance, foreseen to appear every three years until 2014.

Consequences for standards development

This rapid evolution of microelectronic devices places severe demands on both manufacturing equipment and materials, which must be modified, improved, or re-developed in advance of this time scale to meet requirements for making more advanced devices. Early models of new tools and initial quantities of improved or new materials are required to permit development and pilot production of each succeeding generation of microcircuits.

This means standards must be developed or updated on the same time schedule, in a global process, with expert technical participation from every part of the world where semiconductor devices, manufacturing tools, or materials are made. No conventional international standards process is capable of meeting these requirements.

[7] Formerly Japan Electronics Industry Development Association, now Japan Electronics and Information Technology Industries Association.
[8] (U.S.) Semiconductor Industry Association.

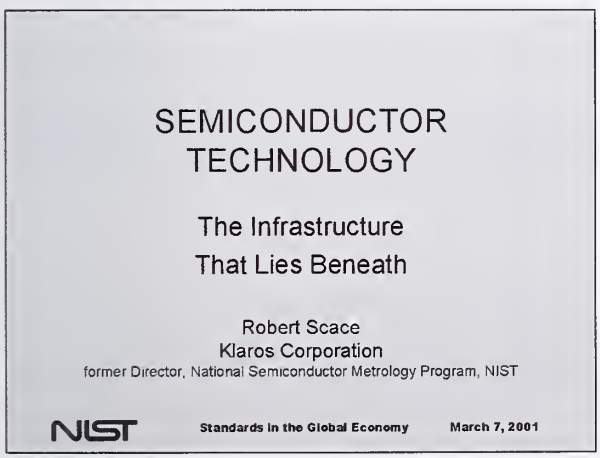
The industry's solution

Most standards for semiconductor manufacturing, by a large margin, are produced by SEMI, a global semiconductor industry association of nearly 2,500 member companies. SEMI has produced about 450 manufacturing standards for the semiconductor and flat panel display industries. Nearly 2,500 individual technical committee members in Asia, Europe, and North America participate in this work. These are voluntary standards, in the sense that their use is not mandated by government authorities, but driven by business needs. SEMI's program is an open, voluntary, full-consensus method of standards development. Being an international industry organization, SEMI does not submit its standards to any national standards organization.

When necessary, SEMI can develop and publish a new full-consensus standard in one year. Revisions can be quicker. Technical committee meeting reports are published on the SEMI Web pages within three weeks after a meeting. Standards whose letter ballots are accepted at a technical committee meeting and also pass procedural review (which can occur during the same week) are published on the Web within two months and in CD form within at most four months. SEMI standards are also published in Japanese on CD and paper and in Chinese on paper.

This creative use of modern communication tools in standards development and in procedural review provides impressive speed of development and publication. The high quality of the standards is indicative of the technical competence of the volunteer members of the program. SEMI, in common with most standards developing organizations, provides quality control of the process but not technical review of the content of a standard.

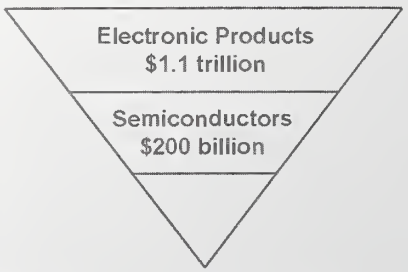
The SEMI process is not international as defined by ISO and IEC, but it is international from nearly any other point of view. The process focuses on the specific needs of a global high-technology industry and serves those needs well. These are business needs, not national or international political needs. The process is global in its use of large international groups of experts to develop standards, in its support from a substantial international consensus for accepting the product, and in its service to an essential international business community. It may serve other fast-moving global industries equally well.



SLIDE 1

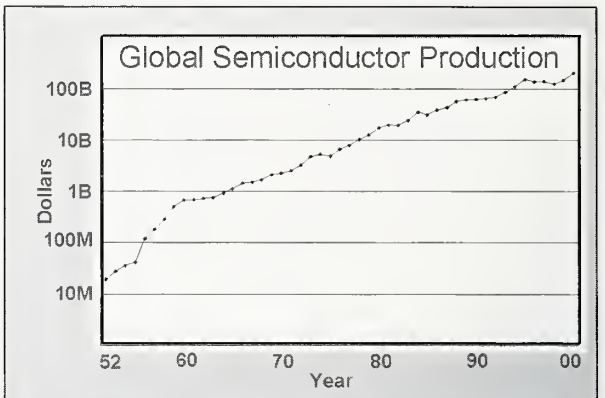
SLIDE 2

The Electronics Pyramid



NIST Standards in the Global Economy March 7, 2001

SLIDE 3



NIST Standards in the Global Economy March 7, 2001

SLIDE 4

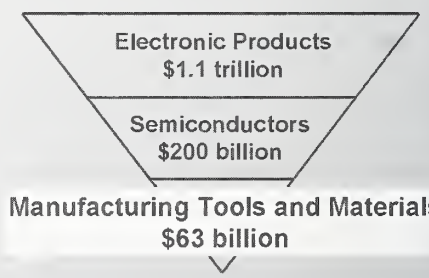
Sources of Documentary Standards

Finished Products:
Transistors, ICs, and Power Devices
EIA/JEDEC, IEC TC-47

NIST Standards in the Global Economy March 7, 2001

SLIDE 5

The Electronics Pyramid



NIST Standards in the Global Economy March 7, 2001

SLIDE 6

Sources of Documentary Standards

For Manufacturing:
Material and Process Test Methods
ASTM, DIN, JEITA
Equipment and Material Specifications
SEMI

NIST Standards in the Global Economy March 7, 2001

SLIDE 7

NIST Standards Involvement

1955 Semiconductor metrology work began
1958 Activity started in ASTM and JEDEC
1975 Activity started in SEMI
1976 Invited to provide ASTM-DIN liaison
1981 Initiated annual meetings among
ASTM-DIN-SEMI-JEIDA

Technical and leadership activities continue

NIST Standards in the Global Economy March 7, 2001

SLIDE 8

NIST Standards Involvement

1989 Industry needs broader technical range of NIST metrology development
1991 New NIST-wide program begins
1993 National Semiconductor Metrology Program formalized

NIST Standards in the Global Economy March 7, 2001

SLIDE 9

Semiconductor Industry's Needs

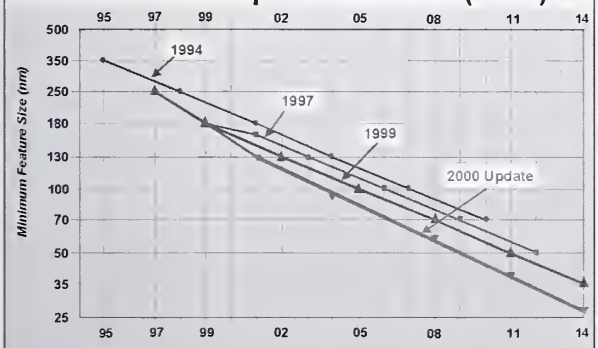
Standards that are
- industry based, not politically based
- globally developed
  - broad base of participation
- globally accepted

TIMELY

NIST Standards in the Global Economy March 7, 2001

SLIDE 10

ITRS Roadmap Acceleration (2000)



NIST Standards in the Global Economy March 7, 2001

SLIDE 11

The Industry's Solution

SEMI International standards program

Started in 1973; international since 1988
450 manufacturing standards to date

Open, voluntary, full-consensus method

Standards not submitted to national bodies

NIST Standards in the Global Economy March 7, 2001

SLIDE 12

The Industry's Solution

New standard possible in one year
Committee reports on Web in 3 weeks
New or revised standards on Web in two months
Publication three times annually
- English and Japanese on CD
- Japanese and Chinese on paper

NIST Standards in the Global Economy March 7, 2001

SLIDE 13

The Industry's Solution

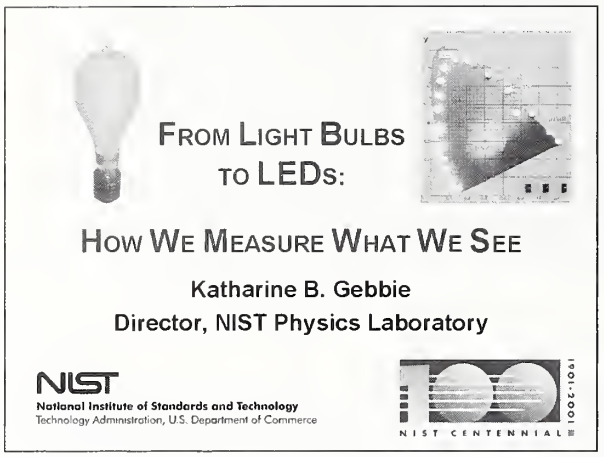
Delivers on time
- Global business needs met
- Global consensus support
- Global acceptance
- International in fact

NIST Standards in the Global Economy March 7, 2001

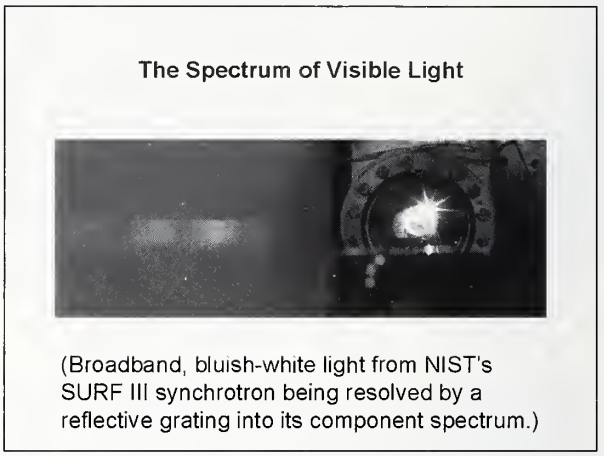
SLIDE 14

From Light Bulbs to Leds: How to Measure What We See

Katharine Gebbie
Director, Physics Laboratory, National Institute of Standards and Technology



SLIDE 1



SLIDE 2

INTRODUCTION

Bob Scace has just told us about the importance of global standards in the development of semiconductor technology—global standards not only as foundations, but also as the stepping stones for advanced technology development. I am always impressed by the history of NIST's involvement in semiconductor standards. The standards for the microprocessor age are based on work done by NIST in the 1950s and 1960s on single transistors, and the standards for single transistors were based on the work done at NIST on vacuum tubes in the 1940s.

One could continue the "begots and begats" back to the earliest work on the fundamental electrical measurements at NIST in its earliest years. While there had been prior international agreement on "practical" electrical units, in 1921 the world community amended the Treaty of the Meter—the foundation of the international metric system—to include electrical units for the first time.

Now, I want to tell you a similar story that also began in the early days of NIST and also had an important milestone in the early 1920s. It is a story that I think shows that global standards, like fine wine, can improve with age.

We have known since the days of Isaac Newton that white light is composed of a rainbow of wavelengths, each seen as a pure color. We have also known that light is a form of radiant energy, with a power that can be measured in watts. But what we didn't know was the relationship between the visual description of light and the physical description, or as it was then called, the mechanical description of light. Fraunhofer made some of the first quantitative measurements of the response of the eye to different colors in 1817, and Langley made the first real measurements of optical energy in 1823. By 1905, Goldhammer had crystallized the idea that there was perhaps a unique relationship between the brightness as seen by the human eye and the energy at each wavelength of the light. At the young NBS, Nutting introduced the term "visibility curve" in 1908 to relate what the eye saw to the radiant power. But we still didn't know what this visibility curve was, that is, the actual relationship was between the visual and the mechanical description of light. The answer to this question was one of the first challenges and one of the greatest triumphs of the early National Bureau of Standards.

Early NBS Experimenters

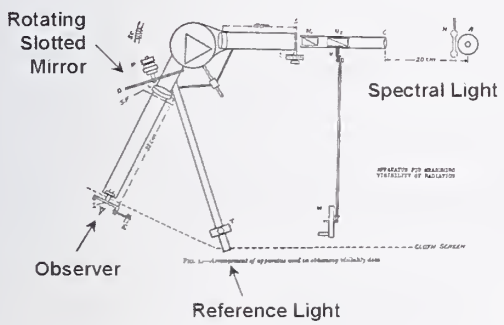
William Weber Coblentz

who, with W. B. Emerson, measured the "Relative Sensibility of the Average Eye to Light of Different Colors" in 1917.

SLIDE 3

By the early 1920s, there were a number of studies of this relationship going on around the world. The main contribution from the United States came from the laboratories of the noted spectroscopist, William Coblentz, of the National Bureau of Standards. He had developed the art of making sensitive and accurate measurements of optical power by using novel detectors of his own design.

The Flicker Method
(from Coblentz and Emerson)



SLIDE 4

In 1917, Coblentz and Emerson built this instrument in an attempt to find the answer. They used the "flicker" methoda rotating, slotted mirror to let an observer look at two lights of different color in rapid alternation. The lights were adjusted until the flickering appeared to stop, that is, when the lights appeared equally bright. The problem was that these data and others collected from other sources were not consistent. Some of the other experiments also used the flicker method, and others used a split-screen viewing method instead. Their differences seemed irreconcilable. Dr. Edward Hyde of the General Electric Research Labs was President of the United States National Committee of the International Commission of Illumination (the CIE). Seeing the need to bring this to some sort of closure, he proposed to the National Bureau of Standards that they conduct an additional study using the so-called step-by-step method. This form of split-screen matching, where comparisons were made between a series of only slightly different colors, held promise as a means of obtaining more reliable data.

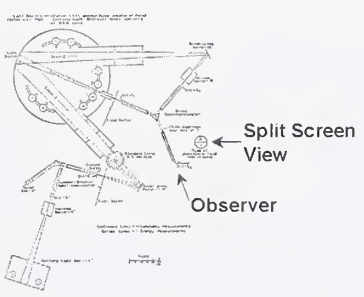
The Fathers of the Visibility Function

K. S. Gibson E. P. T. Tyndall

SLIDE 5

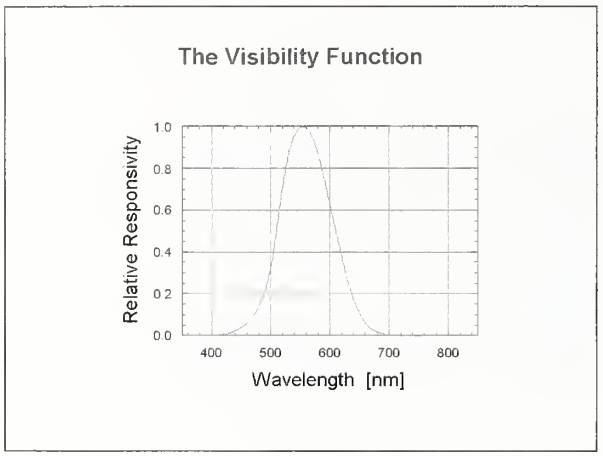
The National Bureau of Standards took on this challenge. The director, then George K. Burgess, appointed a committee to oversee the work, which was carried out by Gibson and Tyndall.

The Step-by-Step Method
(from Gibson and Tyndall)



SLIDE 6

They borrowed equipment from the University of Nebraska, which they incorporated into a quite elaborate apparatus that used some of the National Bureau of Standards' primary standard lamps. They did a careful study and were gratified to see that, in fact, the results were within the uncertainties of the flicker method, but had the precision of the split screen method. Their main contribution, however, was not just in the accuracy of their measurements, but in the very careful analysis and the critical evaluation that they did of all the available data.

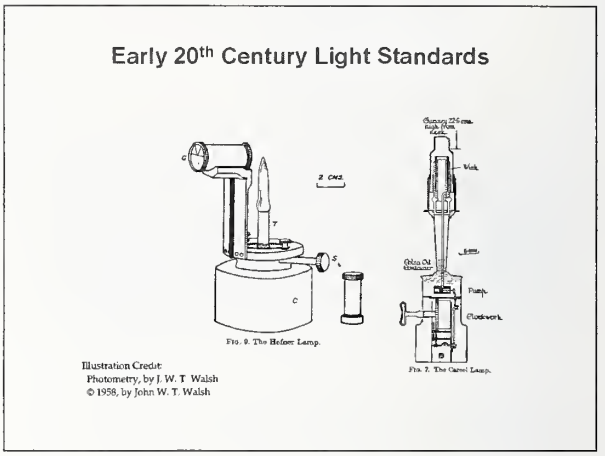


SLIDE 7

They recommended a consensus visibility function that was based on some 200 different observers who took part in the many separate experiments. This was published in the Scientific Papers of the National Bureau of Standards in 1923, and it is one of the NIST papers that was selected as the most important of the past century in the current celebration of our Centennial.

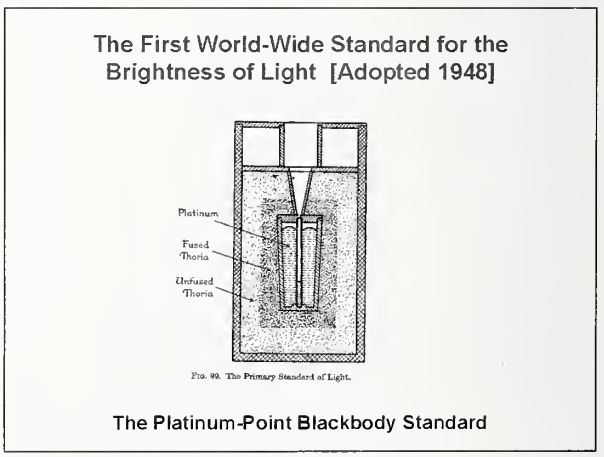
SLIDE 8

The result had worldwide acclaim, and it was accepted by the CIE at its meeting in Geneva in 1924 as a world standard. In 1933, the International Committee on Weights and Measures followed suit.



SLIDE 9

The achievement of Gibson and Tyndall, however, might have remained purely academic had it not been for some changes in the needs of metrology, and advances in technology. As surprising as it seems today, there was until 1948 no unique international standard for the brightness of light. Some countries used gas lamps, and some countries used liquid fuel lamps. Some, like NBS in the United States, used electrical lamps in response to the increasing use of electric lighting at the turn of the century.

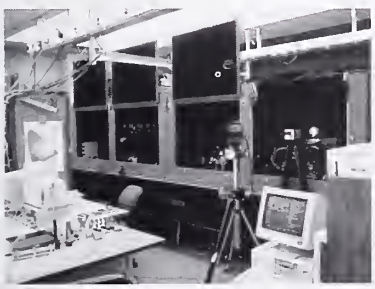


SLIDE 10

This situation changed with the acceptance in 1948 of the platinum-point blackbody standard as the sole

international standard of the brightness of light. The goal in introducing this standard was to improve the stability and uniformity of measurements of light, but in fact it had an unintended consequence in that the behavior of the blackbody could be described using basic principles of physics. This meant that for the first time, unlike with the previous standard lamps, a light standard could be modeled by theory. Suddenly, there was a mathematical model of the entire process of vision, the well-described brightness standard, and the information provided by Gibson and Tyndall on how the eye perceived this light.

Modern Light-Measurement Facility



SLIDE 11

This meant that it was then possible to design and build electrical devices that would measure brightness exactly as the human eye would, or at least the ideal human modeled by Gibson and Tyndall 25 years earlier. No longer did people have to look through visual comparators, a process today called "visual photometry." The era of "physical photometry" began, in which brightness could be evaluated through electronic sensors, yielding better precision and accuracy.

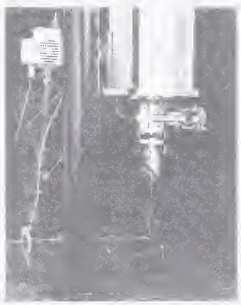
This became so widely accepted that, in 1979, the current standard was born. It is independent of any artifact—such as a candle, a lamp, or a blackbody. However, it does require the Gibson-Tyndall curve to relate the eye's sensitivity at different wavelengths to the reference frequency within it.

Today's International Standard for the Brightness of Light [Adopted 1979]

The candela is the luminous intensity, in a given direction, of a source that emits monochromatic radiation of frequency 540 x 10^{12} hertz and that has a radiant intensity in that direction of (1/683) watt per steradian.

SLIDE 12

Best Practice Today: Detector-Based Radiometry



NIST's High-Accuracy Cryogenic Radiometer

SLIDE 13

In the last 10 years, or so, this has led NIST and other laboratories to develop quite elaborate detector-based radiometry. Instead of having the lamps as fundamental standards, we now use detectors. This produces accuracy something like a hundred times better than that obtained with the lamps, which was previously limited to about one percent. Slide 3 is the NIST high-accuracy cryogenic radiometer, which today is at the root of our measurements of what we see.

Metrology to Support World Trade: Key Comparisons in Photometry & Radiometry

- Photometry
  - Luminous Intensity (directional, from point sources)
  - Luminous Flux (total output from lamps)
  - Luminous Responsivity
- Radiometry [Planned and Underway]
  - Spectral Irradiance
  - Spectral Responsivity
  - Spectral Diffuse Transmittance/Reflectance

SLIDE 14

But having the best possible light detectors is not enough. Without a master artifact standard for reference, how do we provide assurance that a measurement is correct? To support world trade, the citizens of each nation need confidence that measurements systems in other countries are equivalent to their own. To achieve this, NIST and other institutes from member states of the Treaty of the Meter adopted a comprehensive Mutual Recognition Arrangement about a year and a half ago. Through Consultative Committees in each technical field—such as in Photometry and Radiometry—and Regional Metrology Organizations geographically, we cross-check our respective measurement capabilities though well-designed "key comparisons." The results are available for inspection in a public database.

Today, All Photometric Measurements Employ the Gibson-Tyndall Result

SLIDE 15

Gibson and Tyndall could hardly have imagined in 1923 that, over 75 years later, their work would be an integral part of virtually all photometric measurements of light. The international experts in the CIE have tweaked the curve slightly since then, but despite advances in vision research, they have decided to leave the general form of it unchanged. This says something about the enduring quality of global standards.

However, the world today is very different from the world of Gibson and Tyndall. The world of Gibson and Tyndall in 1923 didn't include the narrow-band light sources so common today, like light emitting diodes, phosphor-based fluorescent lighting, and certain high-efficiency lighting that is used for large facilities and out-of-doors. The methods of photometry of the last century are under great stress now for two reasons. First, the premise that there is a single visibility curve that describes the human vision may no longer

A New Measurement Challenge: Solid-State (LED) Lighting

SLIDE 16

suffice. The response of the eye is not linear to very different combinations of narrow band wavelengths—actual perceived brightnesses can differ from the model.

Second, even using traditional practice in physical photometry, we are seeing wide variations in measurement results. Instruments calibrated for the spectra and distribution patterns of traditional lighting can give large errors when used with newer lighting technologies.

Industry Directions / Industry Needs

- Advanced source and ballast technologies
  - Solid-state lighting (LEDs, LEPs, ceramics)
  - Two-photon phosphor technologies (advanced fluorescent lamps)
  - High-efficiency point-sources for light-pipes (centralized lighting)
- Clear definitions and standards for lighting quality
  - Uniform set of performance specs
  - Standard formats for energy and economic data

SLIDE 17

These are challenges that face us today, as we continue to undergo a revolution in lighting technology. Lighting accounts for nearly one-sixth of the electricity used in the United States, $40 billion annually. Advances in lighting, particularly the use of high-efficiency lighting sources, have the potential to reduce U.S. electricity bills by billions of dollars annually, conserve

energy, and reduce power-plant emissions. Industry has responded with new technologies in place and under development. And they have come forward with their needs, including modern standards and specifications.

SLIDE 18

With stakes so high, industry and government have set out their goals in a roadmap for the future: Vision 2020. The items on the last slide were strategies pulled from this report. There is barely time today to discuss the report, but the message is clear: As old as this subject is, it is still a vital one. It is a continuing challenge for industry and its partners vision researchers, standardizing bodies, and government to develop better lighting technologies (such as LED and other solid-state sources), and to evaluate them with fair metrics. And global consensus standards will continue to be needed to support success in the marketplace. Into our next century, NIST will continue to work with U.S. industry, the CIE, and the standards community, to help see this vision through.

Transportation, Materials & Manufacturing

Planes, Trains, and Automobiles

Keith Termaat
Manager, RVT Cross Platform Exteriors/Closures, Ford Motor Company

INTRODUCTION

In this increasingly virtual world, people and products still want to move. This desire for mobility increased when planes, trains, and automobiles displaced animal power. Similarly, the desire for mobility is likely to increase further with exposure to the information highway. Your presence here today, the clothing you wear, and the meals you will eat attest to mobility. A virtual conference would simply not have the same impact. No virtual lobster please!

Mobility is built on standards; some old . . . railroad standards come from Roman roads; wheel ruts which spanned the horse's hind-end. Early automobile standards derived their track from the same source. Other standards are new. Standards for hay-burning transport gave way to standards for transport by petrol. Standards for fuel cell generated electricity will eventually displace petrol power. Time is of the essence in this transformation.

TIME AND STRUCTURE

The auto industry deals with in-car microprocessor events in nanoseconds and driver attention in seconds. Vehicles speed upward of 100 feet per second, trains at 300 feet per second and planes at a 1000 feet per second. The product development cycle approaches thirty months for products lasting ten years or more, using quickly deployed teams. Yet, despite many improvements, the standards system still moves along in furlongs per fortnight in a 24/7 world. It is my premise that this is mainly due to excessive structure.

THE NEW ECONOMY MINDSET

In the movie "Planes, Trains and Automobiles," Steve Martin (a new economy broker) travels by air, rail, and road. He ends up stranded by snow, flood, and mishaps to bunk with John Candy, an old economy shower ring salesman. The point is, even when impaired by weather, new and old economies alike depend on mobility.

The mobility industry has been criticized as stuck in the past . . . despite hi-tech safety, fuel cells, electronics, and polymers. On this point, J. T. Battenberg, CEO of Delphi, refers to the new team on the E-commerce field . . . "the new revolutionaries are from GM, Delta, Wal-Mart," and Ford. The new economy, he says, is a *mindset.* And so it is. Here are some examples:

- Technology is redrawing the Ford global business. I am developing hi-tech solutions to reduce "blind spots" and extend night vision.
- Global external standards are being selected for these technologies.
- Within 5 years, many cars will have telematics capability. Wingcast, the Ford JV with Qualcom, brings digital wireless technology directly into the vehicle.
- Ford.com is the top global automotive website with 124 million visitors last year. These visitors produced $1 billion in new revenue.
- Over 90% of Ford U.S. dealers are on-line; 72% manage sales leads on the web. Last year some 400,000 new leads were handled by our dealers.
- And also, through Covisint, the global supplier exchange, web auctions have generated $1.2 billion in revenue.

As you can see, the web has given us new ways to reach out to suppliers and to markets . . . dealers have adapted and are prospering despite all predictions. Ford and other mobility companies have embraced new economy technology and principles. Dot.com technologies are the means to our end . . . the end is mobility.

THE MOBILE SOCIETY

Society wants reduced energy consumption, lower emissions, lower traffic congestion and more safety. Customers want reduced ownership costs, better performance, more reliability and more comfort. Manufacturing wants shorter time to market and flexible design for product differentiation. Automotive technology mega-trends need standardization, in a timely and efficient manner. For example:

- New power plants, e.g., fuel cells
- Electric components, e.g., A/C
- Intelligent systems, e.g., microprocessor controls
- Light metals and polymers, e.g., magnesium & RRIM
- 42V architecture
- Wireless communication, e.g., telematics.

And these technologies must be 10-year durable, not throw away.

THE STANDARDS DEVELOPMENT INDUSTRY

The standards development industry remains in a furlongs per fortnight world, despite E-gains. Policy, structure, and process require a shift in paradigm. Many companies have headed for the exits; we just don't have the staff to sustain the current hierarchal structure. Here are some indicators:

- ISO fast track has few takers; consortia are winning.
- The structure and process are procedurally level . . . but are not in balance relying as they do on one nation, one TAG and one nation, one vote.
- EU is still too dominant; some kind of weighted TAG structure and voting must be enacted.
- The traditional standards structure is too rule bound . . . reflecting now relaxed antitrust rules from the 1960's and 1970's.
- Some define a "true" standard as having passed muster by a large number of governments. Public policy related to health, safety, and the environment requires government participation; but this model is but out-of-date for technology standards.
- TC22 *paper* ballots are still an option, passing from ISO-ANSI-SAE-TAG, losing time along the way.

Most companies no longer have sufficient staff to work this way—development and voting must be web based. The standards structure today is unsupportable . . . industry cannot commit more people . . . in fact, we will commit less. Standards development policy/structure/process must be streamlined.

SAE LEADING WITH INDUSTRY

Industry leadership at SAE is making the needed changes:

- Have reduced SAE dependence on standards sales to 12% of total revenue.
- Last September, the Technical Standards Board passed the **SAE Paris Protocol:**
  - o "Resolved that effective January 1, 2001, current and new SAE work items include global requirements and be submitted as ISO/IEC or international industry or trade association standards."

The clear intent of the TSB is to further globalize SAE standards development. The larger interests of SAE and the mobility industry require off-setting efficiencies to contain workload caused by the **SAE Paris Protocol**. To that end, SAE TSB will take up at its March Meeting:

- Adding Technical Standards Board members from nations outside the U.S.
- Eliminating a number of standards committees and work groups thereby "right sizing" the structure.
- Reducing (below 40%) the degree to which standards sales support development.

By these actions, we seek to improve SAE global standing, match the number of standards volunteers required to the available resources, and increase SAE market share of professionals in the mobility industry.

SUMMARY

People want mobility with planes, trains, and automobiles, safely, responsibly, and comfortably. Mobility technology requires standards. The formal standards system must change much more; a shift in paradigm is required.

Change starts with modern policy:

- One global standard, one global test, and one global certificate.

Change continues with simple and fair structure:

- Fewer and less hierarchal fixed committees.
- Rapidly deployed, rapidly decommissioned teams.
- Balanced (proportional) TAG influence and voting.

Change finishes with process:

- Web based; no hard copy at any stage.
- Process that needs fewer volunteers.

SAE, in partnership with industry, is acting; we urge you to do likewise.

From Promising to Practical: How Standards Help Bring New Materials to the Market

Presented by **Stephen W. Freiman**
Chief, Ceramics Division, Material Science and Engineering Laboratory (MSEL)
National Institute of Standards and Technology

Written by **Stephen W. Freiman and George D. Quinn**
Ceramics Division, MSEL, NIST

INTRODUCTION

Let us make a bold statement to begin with. Based upon numerous conversations with individuals in industry and elsewhere, it is our conclusion that "For new materials, standards are not a barrier to trade." In this paper, we use the word standard generic in the narrow context of material property test method standards. We do not consider product specification standards. Experience suggests that neither the existence nor the lack of materials test standards enable one country to influence sales of new materials or impedes trade in some way. Indeed, standards sometimes lag behind the introduction of new materials to the marketplace. What then, is the importance of standards?

We recognize several key advantages in having standards. The road for a new material from the research laboratory to commercial application may be smoothed by standards. As a new, improved material is introduced to the marketplace as an alternative to similar materials, data generated by standard methods can facilitate the acceptance of the new material. More radical changes occur when innovative materials and products are introduced for which there are neither precedents nor standards. The path from the research laboratory to the commercial sector is often strewn with pitfalls of data inconsistency that cause confusion, inefficiency, and added costs. Recognition of the problem usually occurs when an innovative material has matured to the point that multiple sources or users are involved. With recognition of the problem comes a commitment to standardization, but the standardization process itself can be time consuming and frustrating and could even delay commercialization.

The ability to make common measurements on the same materials at various places on the globe is critical to world commerce due to the increasing globalization of markets. We must have consensus based standards and specifications. Both users and suppliers of materials around the world need the assurance that the property of the material obtained in one country was obtained in the same way as in another. For new materials in emerging markets such standards are particularly important. In this paper, we will attempt to provide specific examples where standards really made a difference for the entry of new materials into the marketplace.

CERAMICS AS AN EXAMPLE

We intend to use "ceramics" as the broad class of materials from which examples of standards relating to market development will be extracted. Standards are important for other materials as well, but the examples that we will show are wide-ranging enough in character that they make a case for themselves.

It important at the outset to define what we mean by ceramics, because the first thing that people think of when the word is mentioned is usually bathroom fixtures, dinnerware, or tiles. Ceramics are much more than that. Ceramics as a class of materials is extensive, (in some respects, any inorganic, non-metal) and they are present in many different applications (Figure 1). Ceramics are used in these myriad of applications because of their unique structural, electronic, magnetic, and optical properties.

STANDARDS LEAD TO COST SAVINGS

In most applications, the ability to measure the critical material properties is extremely important for the commercialization of these materials. One of the problems with ceramics—well, many of you could figure out—is that they are brittle. So whenever we use them, whether in structural applications such as engine components, or elsewhere, it is important for the designer to be able to predict the safe, reliable operation of a component over a long period of time. So for anyone developing a new ceramic material, being able to accurately measure its strength is an important consideration.

The easiest way to test the strength of a ceramic is to bend it in what is called a flexural test (Figure 2). The rectangular prismatic specimen is cut from ceramic plates or components. This type of test is the bread and butter method of the ceramics industry and is much simpler than traditional tensile strength tests with dog bone specimens. Before the development of harmonized measurement procedures, everything about the flexure test could change from one laboratory to the next. So material suppliers would test their products in different ways, giving rise to the reporting of different properties, because they were, in fact, using a different kind of test. In addition, one of the significant costs in testing of

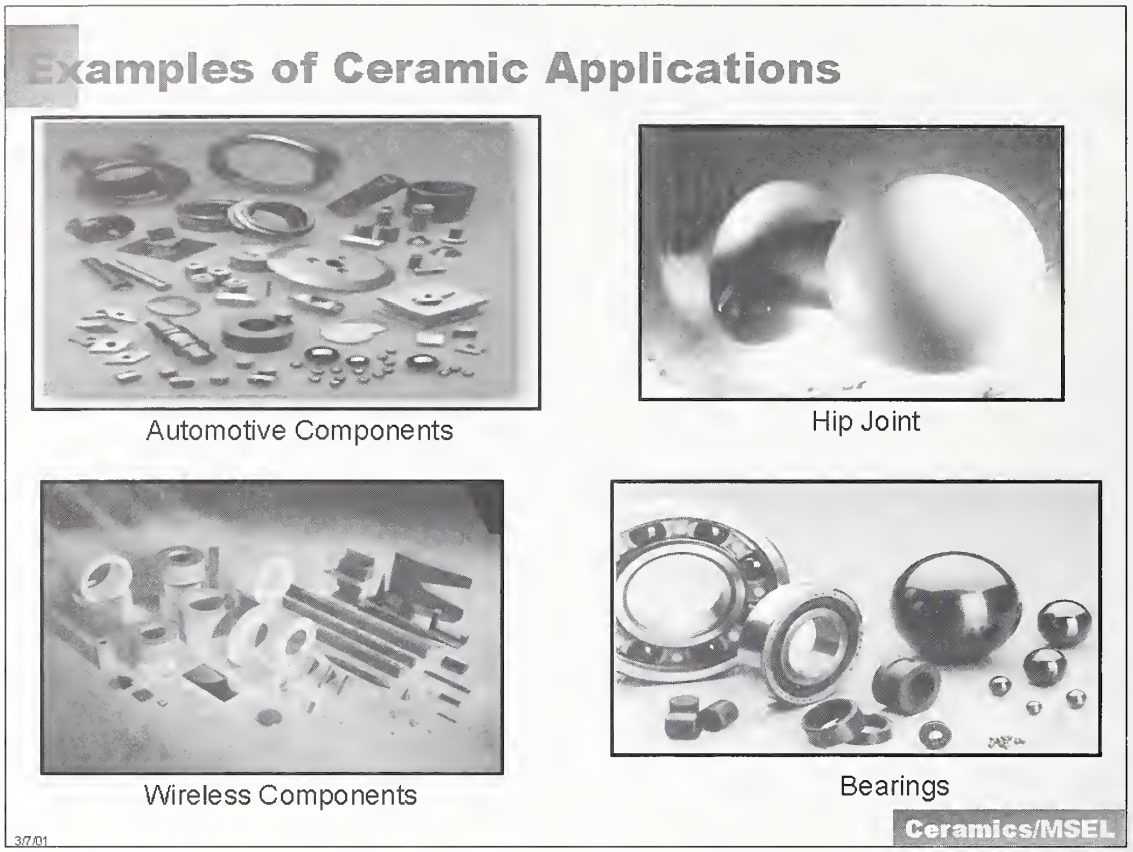


Fig. 1. Examples of New Ceramics.

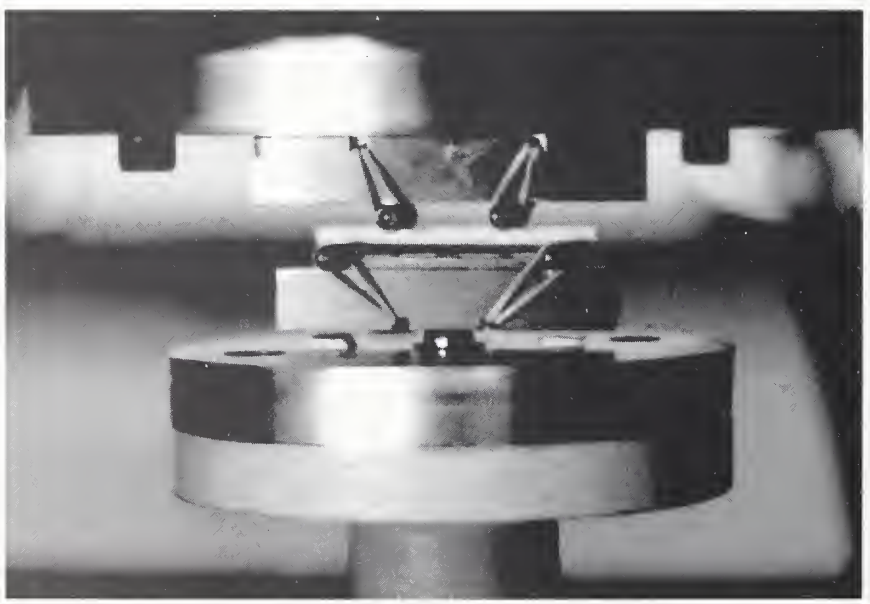


Fig. 2. Flexural testing is the most common method to evaluate ceramic strength. A simple beam specimen (white in the photo) is loaded in a four-point bend fixture until fracture occurs. The standardization of the specimen size and preparation, and the fixture size and type, has led to dramatic improvement in data quality and major cost savings.

ceramics is that associated with machining a specimen. Because of their hardness and susceptibility to damage, machining costs for ceramics are significant. Prior to the development of standards, a typical specimen cost in the range of $20 to $33 in today's dollars. With the development of the American Society for Testing and Materials (ASTM) flexural test standard, the cost of those tests dropped to $8 to $10. Why? Because now standard fixturing could be employed, and machine shops knew that they Ire always going to make exactly the same specimen for everybody, and this allowed the test costs to drop precipitously, resulting in savings of something like $800,000 to $1.5 M a year.

Savings benefits accrued in other ways. Flexure strength testing was often performed for quality control purposes. A producer or user repeatedly tested sample sets of specimens from new batches during the material or product development phase. Prior to standardization, it was recognized that the myriad of methods then in use were not optimized and were faulty. Nevertheless, it was rationalized that the data was good enough for comparative purposes. While this attitude was probably adequate for testing within a single laboratory, the limitations were quickly felt when data was exchanged between multiple producers and users. Data discrepancies led to confusion and even distrust. Furthermore, rudimentary quality control or materials development data often did not meet the more stringent requirements for design or materials specification data. This often led to costly, duplicative testing. The adoption of a simple, technically rigorous, flexural strength standard method solved the problem. Now almost everyone tests the same way. Data collected for quality control purposes is immediately acceptable for the most stringent design applications and the costs of redundant testing have been eliminated. Intangible costs of doubt and distrust have also been eliminated by standardization.

STANDARDS SPEED ACCEPTANCE BY REGULATORY AGENCIES

With aging populations, many of us are going to need replacements for various parts. Biomaterials are a rapidly growing market segment, and artificial hips are one of the most prevalent uses of such materials. At present, most of the balls of such hip replacements are made of metal. But if one wants to replace hips in younger individuals, and leave them in for longer periods of time, then we must look for materials that are more inert, harder, and have better biocompatibility. That's where the ceramic material comes in (Figure 1). However, the use of any new materials for such applications must have the approval of the Federal Drug Administration (FDA). The FDA would like to see standards and specifications in place to enable them to more rapidly certify new materials. Although the FDA has the authority to write regulatory standards, they now rely on consensus standards developed in both national and international venues. Standards for biomaterials have been developed through ASTM, originally in the committee on advanced ceramics, C-28, who wrote the standards for basic material properties, namely strength, hardness, fracture toughness. Committee F-04 specifically dealing with medical materials and devices then used these standards to develop more detailed implant material specifications.

STANDARDS FACILITATE PURCHASING

One especially relevant example of the importance of new materials to modern technology, and of where standards can be influential, is the cellular telephone, and wireless communication in general. Without going into detail, we can state unequivocally that wireless communication would not exist today were it not for the unique electrical properties of key ceramic components. The development of these new materials for the wireless industry provides a good illustration how lack of standards can directly affect commerce in new materials. The following examples are particularly interesting because they are paraphrased from comments made by one of the leading manufacturers of wireless materials in this country:

- One problem with the lack of standards is that one company can promote its material over another, when in fact the only difference between the two materials is the fact that their properties Ire measured in two different ways. One sees apparent conflict; the buyer is not quite sure which is the right property of the material.
- Another important issue is the potential confusion in interpreting data. If one isn't sure how the particular property was measured, then there is clearly a problem in understanding what that property is.
- Thirdly, two vendors may supply a different product even though the material was ordered to the same specification.

All of the above conditions lead to the overall problem that customers may have to qualify each of its vendor's particular products.

WHEN ARE STANDARDS NEEDED IN THE DEVELOPMENT PROCESS

Finally, we want to touch on the issue of timing in the development of standards relative to the application of new materials. When a new material is developed, and if there is only one company manufacturing it for a particular application, specifications can result from a private agreement between the manufacturer and the end user. At this stage it is relatively easy to have this kind of communication. As the material matures, however, more manufacturers of ostensibly the same material appear, and there are more end-users that find the material attractive. At this point some kind of standard becomes important, because it defines the way that the critical properties of the material should be measured.

An example of such timing can be shown in the development of ceramic bearings. Because they can operate in inert environments without the need for lubrication, ceramic bearings are becoming more and more prevalent in applications such as high-speed machine tools, turbo pump motors, food processing equipment, and even dental drills. Initially, however, before the markets for such bearings developed, only a relatively few materials (essentially different varieties of silicon nitride) were available. Individual manufacturers agreed with individual users on the properties that Ire needed. As the market matured and users groomed second sources, these informal arrangements were no longer sufficient. A new effort has now been developed within ASTM to write formal standard specifications for these materials. In this instance the process will be expedited by the existence of a battery of generic ceramic test method standards, already on the books, that are eminently suitable for the bearing industry.

In contrast to the bearing case, radical new materials and applications may develop for which there are no standards. New materials often require new methods and frequently a variety of expedient test methods arise. No one wants to spend a lot of time and effort on refining test procedures when the material, product, or the market is unproven. Eventually it becomes apparent that the multiple methods are creating confusion and doubt. It seems obvious that a consensus, standardized method is needed, but by then, large internal company databases have been compiled. There may be a genuine reluctance to have such rendered obsolete. The recognition that standardization is needed usually occurs when a material, or product has reached the point that multiple venders or users wish to compare data with confidence and minimum fuss. At this point the interested parties may come together in consortia or in formal standards development organizations such as ASTM, and the process of forging a consensus standard begins. Once standardization is accomplished, the impediments of data incompatibility, data distrust, and duplicative testing are usually eliminated and commercialization proceeds more smoothly. We will not venture far done the path of describing how standards are created, but I make two generalizations. Experience suggests that the sounder the technical basis of a method, the easier it is to achieve agreement and the more the prestandization groundwork that has been accomplished, the faster and less contentious is the formal standardization process.

MATERIALS PRESTANDARDIZATION RESEARCH

We can define prestandardization research as being the collective activities of a group of laboratories to establish a measurement technique and agree on a uniform procedure for carrying it out. Prestandardization research is often conducted by leading national institutes such as NIST, NPL, and BAM. One organization that promotes such collaborative work is the Versailles Project on Advanced Materials and Standards (VAMAS).

VAMAS was formed in 1982 as one of 18 such cooperative projects, at the economic summit in Versailles, hence the name. The mission of VAMAS is to support world trade in products dependent on advanced materials technologies by providing the technical basis for harmonized measurements, testing, specifications, and standards. VAMAS promotes collaboration among the outstanding materials laboratories throughout the world, bringing together experts in many materials fields. VAMAS is governed by a steering committee composed of the signatories of the agreement, plus the European Commission. This steering committee is currently chaired by the U.S., through NIST. However, researchers from many other countries participate in the work of VAMAS.

VAMAS has formal linkages to both ISO and IEC, and perhaps of equal importance, the individuals who participate in VAMAS are typically also participating in their national standards bodies and in international standards development. These individuals see each other frequently, work together, and ultimately develop a mutual trust, which facilitates the development of standards on an international basis.

There are now 18 technical working areas in VAMAS, Table 1 addressing many different aspects of materials. Table 2 illustrates how, in the area of ceramics, VAMAS work has led to national, regional, and international standards.

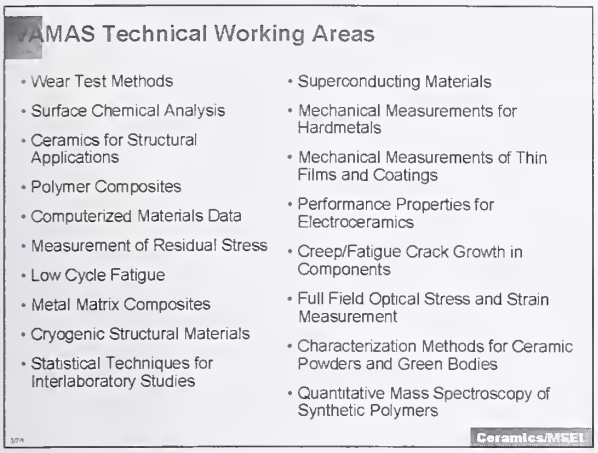


Table 1

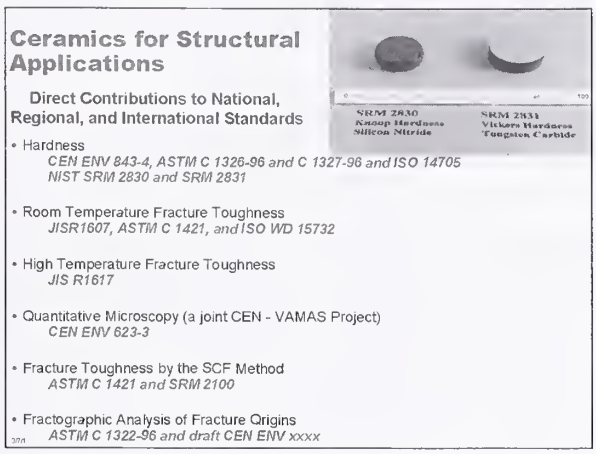


Table 2

SUMMARY

In summary, standards are important and facilitate commerce in new materials for a number of reasons. First, they help produce reproducible consistent data. They lead to better specifications for materials and so the buyer, the end-user for whom these materials are important, knowing the true properties of that material, can select the material which best suits his application,. Specifications for ceramics are not nearly as prevalent as those for metals, but they are rapidly emerging. Standards, and the writing of measurement procedures, will lead to better specifications.

Thirdly, standards lead to harmonized performance characteristics, which in fact is what we are looking for. Further, for a new material, the existence of a standard immediately makes that material more credible, more Ill-known, and more likely to be selected for a particular application. Finally, standards can be educational tools, in that they can instruct the end-user even as to what the material looks like, and how it should behave.

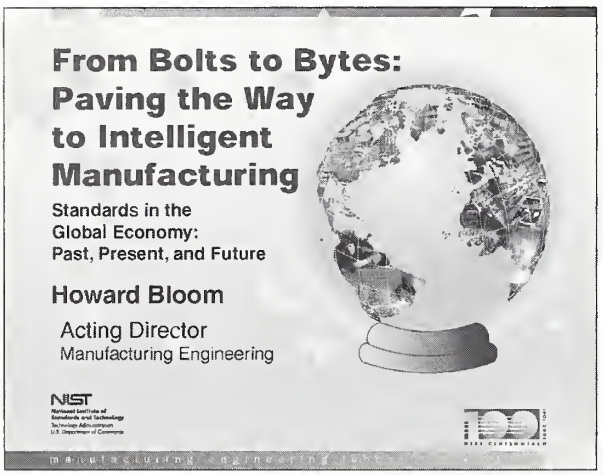
So, we see a definite relationship between standards and the commercialization of new materials. The existence of standards promotes new materials, and paves the way for their introduction into the market-place. In addition the standard aids the end-user by providing the kind of data that is needed in order to put these new materials in place in a wider variety of applications.

From Bolts to Bytes: Paving the Way to Intelligent Manufacturing

Howard Bloom
Acting Director, Manufacturing Engineering Laboratory
National Institute of Standards and Technology

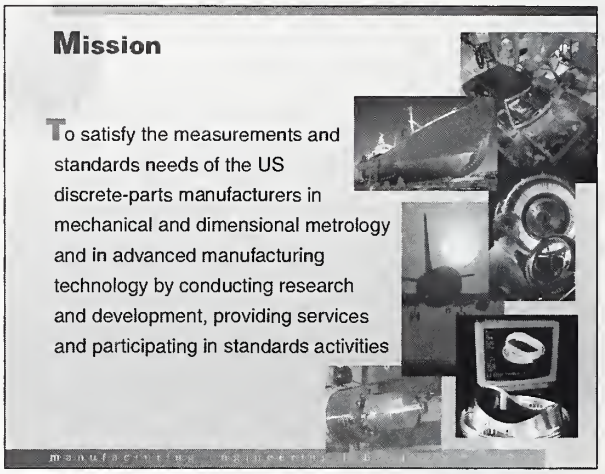
INTRODUCTION

Good Afternoon. The title of my talk basically reflects the trend in technology in manufacturing over the last 20 years. We at NIST have done our part to try to keep up with the concept of moving from bolts to bytes, and seeing how much information technology has influenced the ability of our manufacturers to be more productive. (Slide 1)



SLIDE 1

I will specifically talk through a couple of examples, starting in the past and taking one into the present, and then look a little bit into the future to show how we go about satisfying the standards needs of industry through what we do. Let me just repeat the idea that our laboratory efforts in the Manufacturing Engineering Laboratory (MEL) are mainly oriented towards the discrete parts industry, to which we bring our core experience in dimensional and mechanical metrology, and now our growing expertise in advanced manufacturing for solving our industry problems. (Slide 2)



SLIDE 2

Just as some background—I don't expect you to read the details—but this is the portfolio of standards that we are working on, first from a national standpoint, and then from an international perspective. We work on a variety of committees in the area of dimensional and mechanical metrology. Also, because of the nature of the industry, we work on standards activities related to robotics, machine tools, and manufacturing interoperability, as well as how to put everything together, in both national and international committees. We at NIST are very dedicated to this work in order to produce the needed standards. (Slides 3 and 4)

National Standards Organizations with MEL Representation

American Measurement Tool Manufacturing Association (AMTMA)
Committee on Uncertainty and Rules on Conformance

American National Standards Institute (ANSI)
ANSI B212, Cemented Carbide (Cutting Tools)
ANSI S001, Acoustics
ANSI S002, Mechanical Vibration and Shock
ANSI S003, Bioacoustics
ANSI -C083, US TAG for ISO/TC108, Mechanical Vibration and Shock
ANSI -C084, US TAG for ISO/TC108/SC.03, Calibration of Vibration & Shock Measuring Instruments
ANSI -C100, US TAG for IEC/TC087, Ultrasonics
ANSI -C108, US TAG for ISO/TC184/SC01, Robot

Acoustical Society of America (ASA)
ANA -C001, Committee on Standards
ANA COS, Acoustical Committee of Standards

American Society of Mechanical Engineers (ASME)
ASME B1, Screw Threads
ASME B5, Machine Tools - Components, Elements, Performance, and Equipment
ASME B46, Classification and Designation of Surface Qualities
ASME B89, Dimensional Metrology
ASME C010, TAG to ISO TC 030, Measurement of Fluid Flow in Closed Conduits
ASME H213, Special Committee on Harmonization of Dimensional and Geometrical Product Specifications and Verification

American Society for Testing and Materials (ASTM)
ASTM E7, Nondestructive Testing
ASTM E28, Mechanical Testing
ASTM E41, Laboratory Apparatus
ASTM E42, Surface Analysis
ASTM F1, Metrology Committee

Electronic Industries Alliance (EIA)
EIA IE031, Numerical Control Systems and Equipment

Robotics Industries Association (RIA)
RIA R15, Robotics Standards

Society of Automotive Engineers (SAE)
SAE -C002, Lighting Coordination Electrical Systems Group

Semiconductor Equipment and Materials International (SEMI)
SEMI Standards
Metrology
Microlithography

US National Committee for IEC (USNC/IEC)
USNC/IEC TC029, Electro-Acoustics

manufacturing engineering laborat

SLIDE 3

International Standards Organizations with MEL Representation

Conference General des Poids et Mesures (CGPM)
CGPM -C001, Consultative Committee on Mass and Related Quantities
CGPM CIPM, International Committee on Weights and Measures

European Accreditation Association (EA)
EA Dimensional Metrology Technical Experts Group

International Federation for Information Processing (FIP)
IFIP TC005, Computer Applications in Technology

International Electrotechnical Commission (IEC)
IEC TC029, Electroacoustics

International Organization for Standardization (ISO)
ISO TC 039, Machine Tools
ISO TC 108, Mechanical Vibrations and Shock
ISO TC 135, Nondestructive Testing
ISO TC 172, Optics and Optical Instruments
ISO TC 184, Industrial Automation
ISO TC 213, Dimensional & Geometrical Product Specifications and Verification

Object Management Group (OMG)
OMG-C002, Domain Technology Committee

Organization Internationale de Metrologie Legale (OIML)
OIML-C006, International Committee of Legal Metrology
OIML-TC09, Instruments for Measuring Mass and Density

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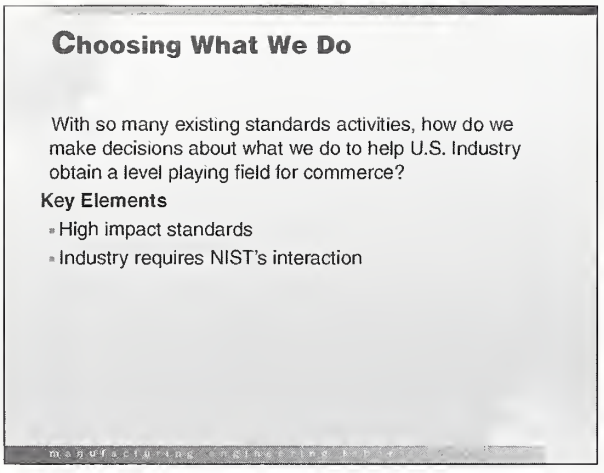
SLIDE 4

NECESSARY STANDARDS

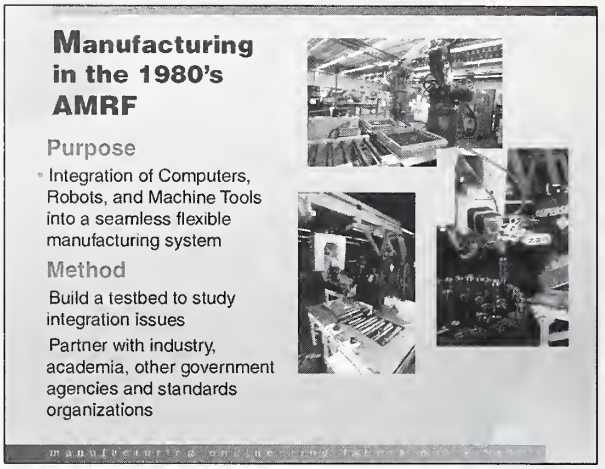
I'm going to start on a theme now, which I will come back to a little later. We at NIST contend with the problem created by the great variety of standards that we must work on. How do we choose which ones to tackle, and how do we choose the level at which to work? The goal, of course, is to look at these standards and make sure that there is a level playing field, so that all industry can work hard, be productive and have an equal opportunity to make a profit. Two key elements associated with that are the decisions that we have to make. One is the expected impact—the financial impact, or the productivity impact—of having that standard in place. Let's not just produce a standard for the standard's sake; it must have an impact. (Slide 5)



SLIDE 5

Secondly, why does NIST need to be involved? If industry can do it without NIST, we don't need to be involved. We need to limit ourselves to those cases where there is a true need for our core competence to be involved in getting a standard developed; I am going to come back to this a little later.

I will start with an example from the past to give you a flavor of the culture in our laboratory and how we decide to work on standards activities. In the late '70s, and in the '80s, there was a great deal of interest in flexible manufacturing and an expanded viewpoint of the "lights out" factories—that is, the intelligent factories—where you could store a lot of orders for products, put them on- line, and come back the next day, and the finished products would just be sitting there on the table waiting to be sold. (Slide 6)



SLIDE 6

Things today still haven't yet reached that, but in the '80s, we put together a program called the Automated Manufacturing Research Facility (AMRF), where this interest in flexible manufacturing became the paradigm for how we were going to work on standards. The key thing was building a test bed. We were looking at the integration of computers, robots, machine tools, and measurement machines. We were concerned about how you could have effective standards to make sure that these systems worked well together, and that their performance was effective. You don't want to produce a standard unless you really see in a prototype environment that the standards are not going to inhibit your ability to manufacture, but are going to help it. So we put in place a test bed in our laboratory at NIST.

The second part, which is even more important—and whenever I use the term "we" in the rest of my talk, "we" will not refer only to NIST. "We" will refer to the fact that the only way we can really go about doing things is by working together with partners. We had a huge complement of industry coming to NIST and working with us. We were very involved with standards activities as we were developing the test bed. We must have had over a hundred companies, through the 10 years or so that the AMRF was operational, working with us to ensure that we were benefiting industry.

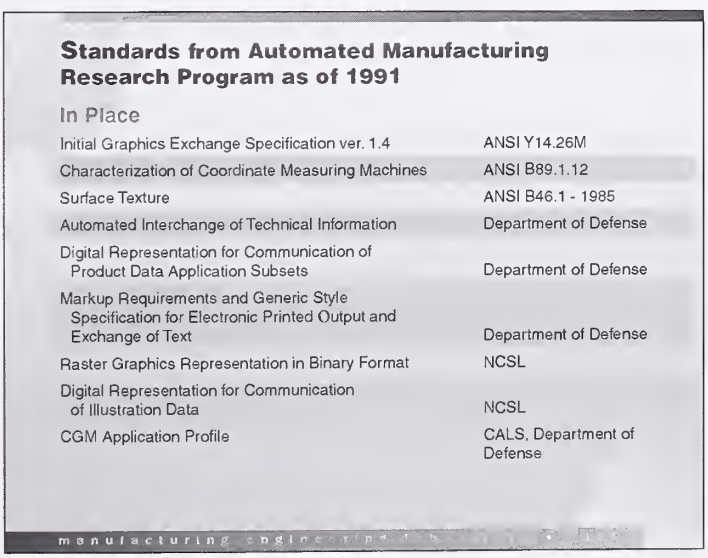
The test bed had seven work stations. Each workstation consisted of a robot, a machine tool, or a measurement machine, or a robocart or some kind of automated storage and retrieval system. We were looking at how to take the metrology that we had learned from our basic dimensional and mechanical metrology core competence, our knowledge of control systems, and

SLIDE 7

how to combine them together to anticipate the kinds of products industry was going to market in the '80s and '90s using flexible manufacturing. Then, through this combination we would develop the necessary standards and performance measures. One of the lessons that we learned from this was that industry has got to commit to using the standards. It doesn't do any good if an Standards Developing Organization (SDO) produces a standard if industry itself is not going to use it. I have heard that several times this morning—I think somebody was talking about ISO9000—if industry is not committed to it, it is not going to work. It is also not enough for industry to say that they are going to use the standard. Industry has got to tell the vendors that they will only buy products that conform to and satisfy the standards. Otherwise, the vendors are not going to build to the standards.

You need to be very engaged in the standards organization. In our case, we knew that the technologies were going to take 5 to 10 years to reach the market place, so we had time in those days, in the '80s, to work with the standards bodies and try to grease the wheels so that when the technology was there, the standards would be there, too.

The last point about the AMRF is that we did not do the job that we should have done in terms of formalized testing to ensure that when the standards were in place, the right kinds of testing protocols would also be in place, so that we could be sure that products would conform to the standards.



SLIDE 8

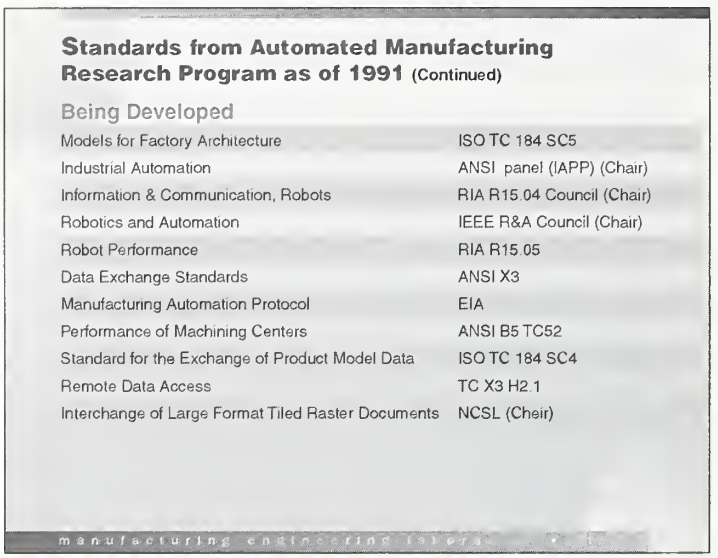
The slide (Slide 8) shows some of the standards that came out of the AMRF. This was published in '91 when we were winding down the AMRF. Many of these were interface standards.

The first standard, the Initial Graphics Exchange Specifications (IGES), is an interesting standard because people are still buying IGES today. It is 20 years later and some people—especially in small companies—are still exchanging drawing data using IGES.

Some of these standards in the area of performance standards that we were working on in the '90s have matured over the last several years. (Slide 9)

By this I mean, how do you know a robot is performing correctly, and how do you know that a coordinate measurement machine is doing what you want it to do? How do you know if a machine tool is performing according to specifications? We've spent a lot of time in the last 10 years, and will spend more in the future, as new technologies produce more and more intelligent robots and machine tools, to come up with more and more intelligent ways of measuring their performance.

Now, I want to emphasize that there is one thing you should remember from my talk. You can't develop standards without a business case. That may sound a little funny coming from the government, but this is really the truth! (Slide 10)



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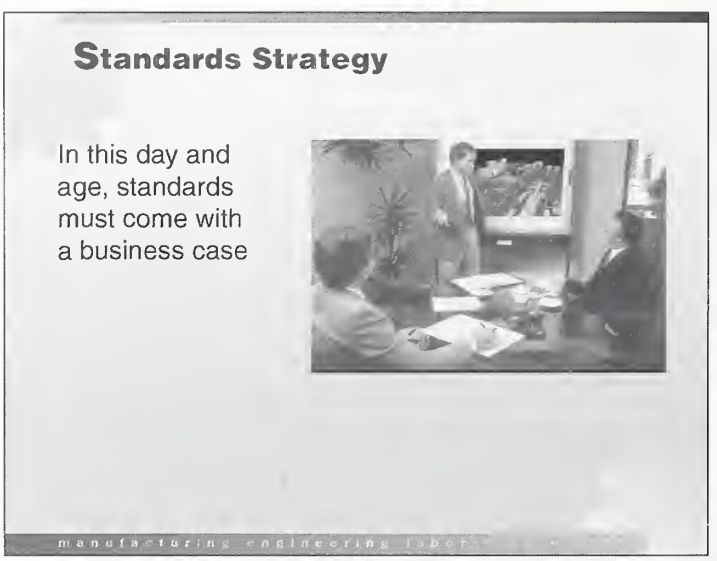
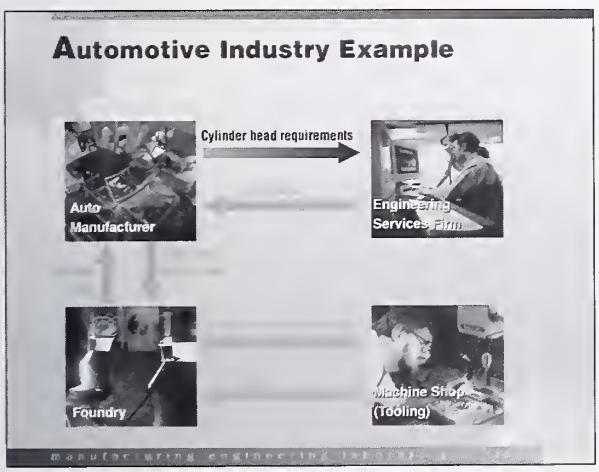


SLIDE 10

No standard is worth developing unless you can justify an economic benefit. I also heard this morning about how the number of people that companies put to work on standards committees is considered a cost. We shouldn't be doing it unless we can see at the other end that the standard is going to benefit the company. The one message to go away with is that you have to have a business case for developing a standard!

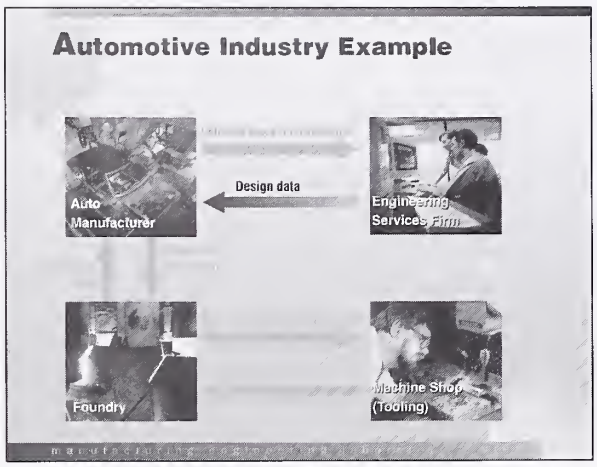
Now, I'm going to go quickly through a standard that my laboratory is probably very well known for, in terms of product data exchange. We have been working on this for 15 years, are still working on it, and may be working on it for the next 15 years. In that sense, it will certainly survive my lifetime here at NIST. But let me give you an example, and this will lead into what I mean by business case.

We became aware of an auto manufacturer, but I won't say which company it is. The auto manufacturer needed a new cylinder head design, and sent the requirements for it to an engineering service to come up with the design. (Slide 11)



SLIDE 11

Okay. The engineering service took those requirements and used a computer aided design system with which they were very comfortable. They shipped the design data back to the automotive manufacturer. (Slide12) Okay. Now the automotive manufacturer needed to have that cylinder head made in a foundry, (Slide 13) but unfortunately the foundry did not have the same computer aided design system. So the manufacturer had to use its own computer aided design system to do some kinds of translations, then send that data down to the foundry. The foundry, of course, needed to have some tooling made, and, as it happens, it had its own computer aided design system. (Slide 14) It took this design data and shipped it to a tooling supplier in order to make the tools that it needed. The tooling company, of course, had a different computer aided design system, so it had to do some translations on its own. It did all of that, and then sent the tooling back to the foundry. (Slide15) The company was very happy. It had its tooling, could now manufacture the cylinder head, and so it sent the head to the automotive manufacturer.



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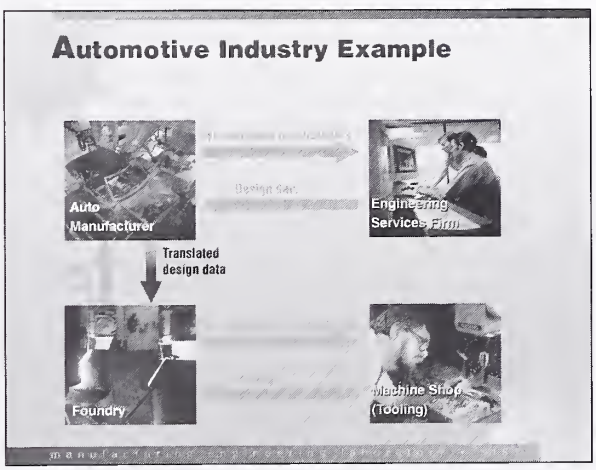

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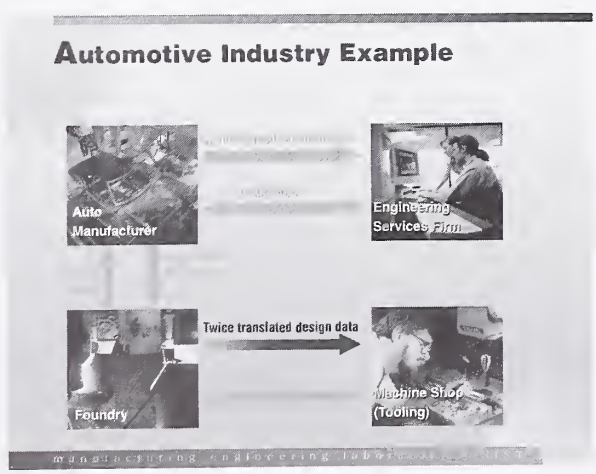

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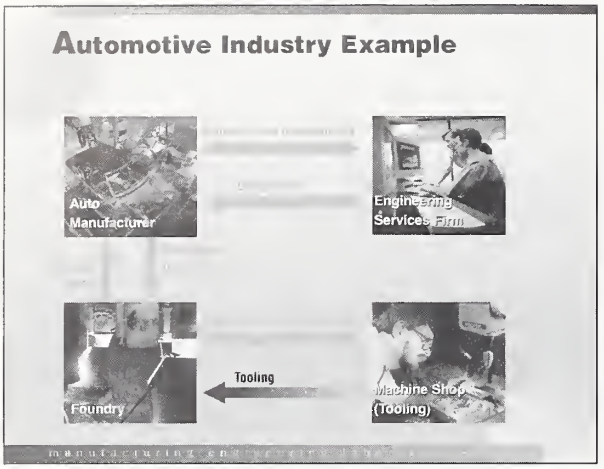
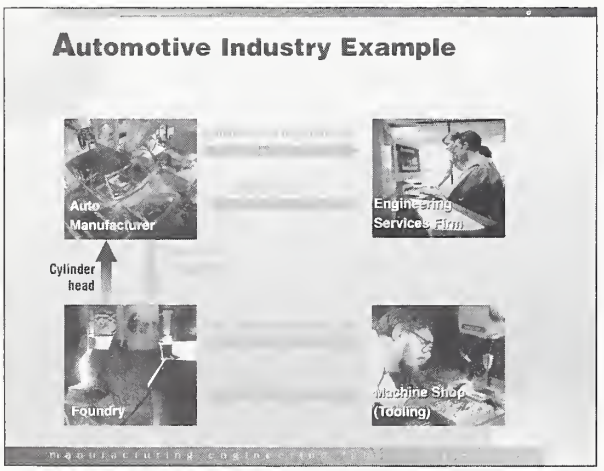


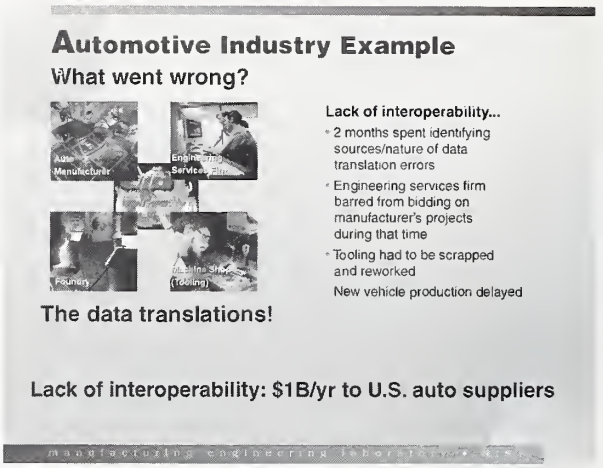
SLIDE 15

The cylinder head came back to the manufacturer, so you may think that everything is great? (Slide 16) Well, something went wrong. The cylinder head did not fit. What went wrong? Another message I want you to go away with is lack of interoperability. We have been talking a lot about interoperability in the Information Technology (IT) world.



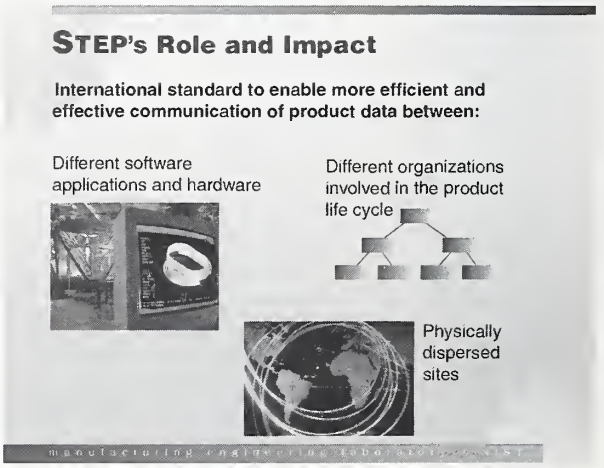
SLIDE 16

Two months were spent trying to figure out what went wrong in this case. By this point, the engineering service firm no longer was doing business with the automotive company. Tooling had to be scrapped. The problem is data translations—data translations—data translations. (Slide 17) We did a study on this, which we published last year. I think that almost every industry sector has taken this study and tried to apply it in terms of the sector's interoperability issues. Our study was done primarily with the Automotive Industry Action Group (AIAG), which showed that at the very least, there is $1 billion a year lost due to unsuccessful data translations because they weren't using a standard.



SLIDE 17

This is what I mean by a business case. Let me give just the first step for interoperability. The STEP is the STandard for an Exchange of Product model data. It is part of the ISO community and is in TC-184, which is the Industrial Automation Technical Committee, in Subcommittee 4. We have been working on it since 1984 and again the "we" here is 26 countries, and over 400 technical people who have been working year in and year out on the standard. The standard was meant to satisfy the problems of moving data between CAD systems and other systems that represent product data. It is supposed to work with different software applications, different places in the supply chain, and over dispersed sites. (Slide 18)



SLIDE 18

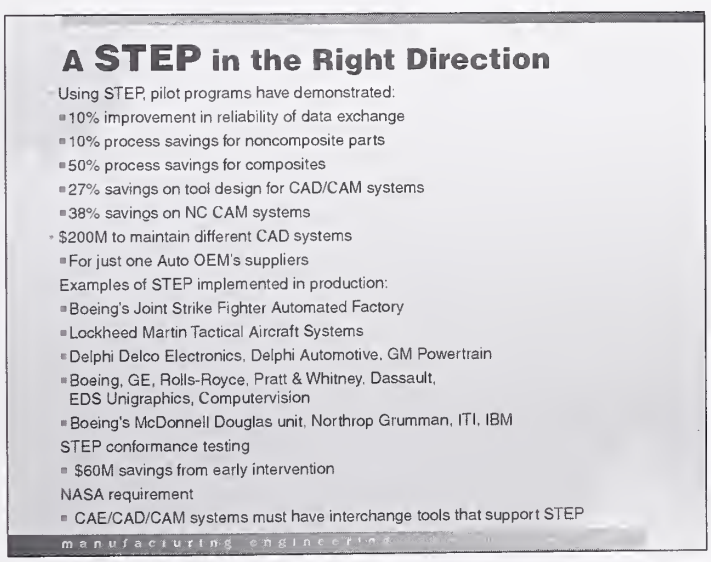
Now, why was this standard a success? Number One, even though I am a government employee, it was industry driven. The government did not issue an edict saying we are going to have this standard. Industry said that we need to have a standard. There was a commitment by industry to use the standard. The push for a standard

came from large companies, which could put the pressure on vendors who were developing the software to actually write the STEP translators. (Slide 19)

Another key element was that there wasn't a "Microsoft" already there with a system in place. There weren't a lot of Computer Aided Design (CAD) systems that could do the things that the STEP community envisioned, for we were looking 5 years beyond the existing CAD systems. There was no power conflict between two or three CAD companies urging use for one particular system—"Use my system as it is now as a standard." No one had the total system, so that made it easier to solve that problem. Finally, it was an international, rather than a national, effort. As I said, in the '80s the United States had IGES. Germany had its system, and France had its own thing. We decided that we weren't going to go that route. We, as an international community, decided that the only way to have an effective standard was to develop it internationally. Finally, we deliberately built conformance testing directly into the standard.

Here are some of the savings that you can see documented on some websites. In the United States, a standards organization called U.S. Pro Data managers the U.S. activities in STEP. You can also look on the ISO TC184/SC4 website. There have been tremendous savings. Pilot programs that companies have worked on have shown great savings. (Slide 20)

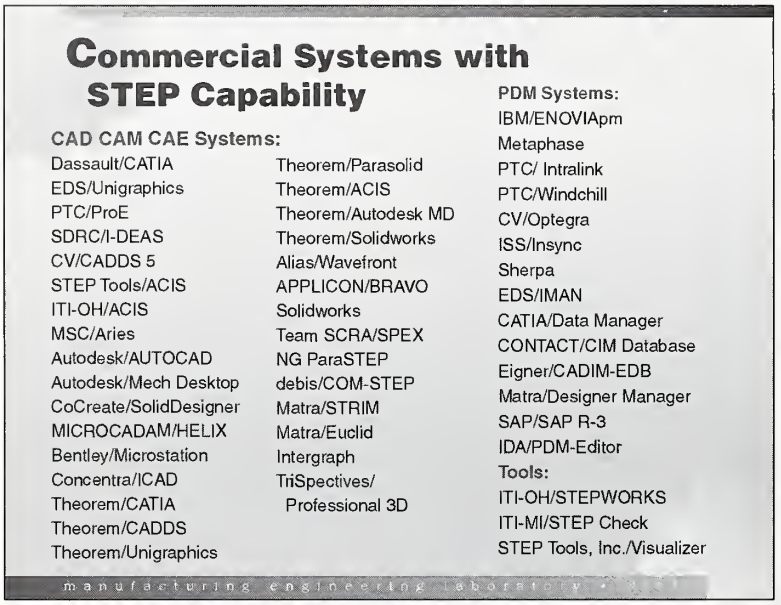
SLIDE 19



SLIDE 20

On the other hand, companies have reported that they spent millions of dollarsone company spent $200 million maintaining 3 different CAD platforms—and if they had only had STEP they wouldn't have had to do that. So again, lots of benefits. Many companies are using STEP; it is for real! It has been in place now for six years. It is an evolving set of standards so that with each new application, a new standard comes about. (Slide 21)

But there are also problems that we learned with STEP. One was that we were trying to initially say was that one collection of data represented all the things that you might want to do with product data. This was a huge amount of data. It didn't work. (Slide 22)



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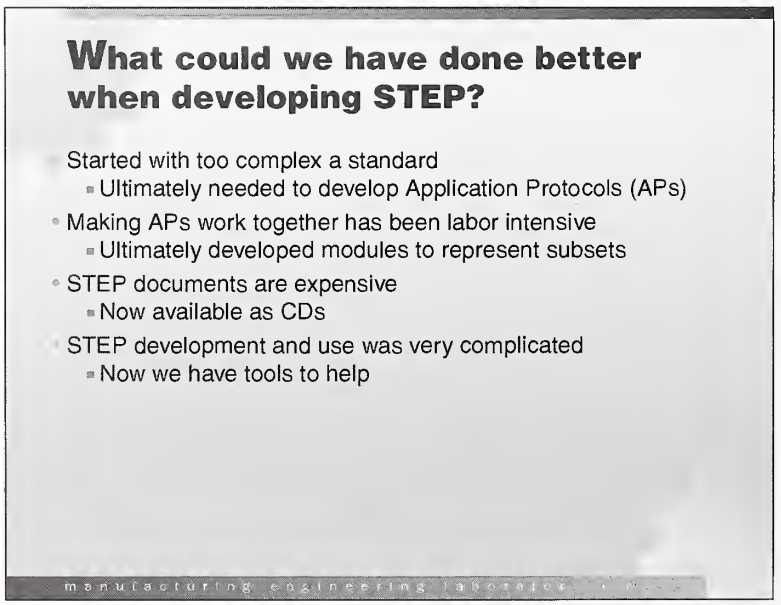


SLIDE 22

We had to step back from that and decide that what we needed to create was what are called Application Protocols (APs). We would ask what we would need to do if we wanted to exchange finite element analysis data or geometry data. What if we do something for shipbuilding, instead of the automotive industry or process plants? So we developed a variety of AP's to make things smaller and more efficient. Now that caused a problem, and it was hard to integrate these protocols later. The solution now is to have lots of little modules that are independent of the application protocol so that you can build the application protocols out of these modules.

This morning we talked about the cost of documents. First of all, a typical STEP AP might be 5,000 pages. That is a lot of paper and it has been selling for $500 to $1000. Consequently, we are now going to CD's to get the costs down. Obviously, it would be great if STEP was free. The development itself is very complicated, so over the years we have had to develop a lot of tools. I think that whenever you have a complicated standard, you might want to consider in advance the kinds of technology tools that you could develop to make it easier to get the standard in place.

In this last minute or two, I want to look into the future. You have heard about flexible manufacturing, and taken a beginning look at interoperability.

What is the global economy going to look like over the next 20 years? (Slide 23) The Internet, or whatever comes after that, is going to transform manufacturing

SLIDE 23

into totally distributed enterprises. We are beginning to see some distributed enterprises now. We are observing many mergers of companies internationally. Information is going to be deposited throughout the world: parts datawill be in one place, with process planning data and manufacturing data in other places, scattered throughout the world. Electronic commerce is going to get bigger and bigger, as talked about this morning. The need to do business, to negotiate, buy, and sell—all of this is going to be done remotely.

This will require interoperability, complete interoperability; the seamless, high fidelity exchange of data between different systems, without any loss or corruption, and seamless integration, because this is going to be computer to computer. Nobody is going to be looking at the data as it flies by, a hundred megabytes or whatever at a time.

What can we do to help the process from a viewpoint of standards? One thing is to look at common languages for the formal specifications of our standards. Many of our standards documents are written in English or in French, but there is some ambiguity in what you read. (Slide 24)

SLIDE 24

In the STEP community, we developed the language called Express, a formal language that is very clear and unambiguous, so that you know exactly what the standard represents. From that, the testing was very simple to develop. In STEP there are standards called abstract test suites. It was very simple to do that because we had the unambiguous modeling language for the standard (Express) to be written in. In addition, we are going to need testing built into the standards in the future, so no standards should be issued without testing specified in it.

There will be certification for vendors. We really need to put pressure on companies and vendors not to buy anything that hasn't been certified, that you know will really work.

Another thing that people talked about this morning was the amount of time consumed in meetings. As

Mike Hogan and others discussed this morning, I believe that the interactive nature of standards meetings and the way the information is exchanged will in the future be Internet based meetings. We can't afford to travel around the world. It takes too long. We should be able to do more over the internet, and we ought to use collaborative software for gathering requirements for analyzing the standard, and for making decisions about the standard, rather than what we do now.

We will also see SMART systems, as in the area of manufacturing interoperability. These systems will be able to go out just as we do with fax machines today, query a system and figure out what language or what kind of semantics that system has, connect it to another system, and query that other system. It should figure out what kind of semantics and language another system has, connect the two together, and solve the problems of interoperability.

My dream of the future is that we will have a harmonized integrated set of standards for manufacturing, and companies will only procure systems that are formally certified.

Thank you.

Building & Construction

Putting Safety First: A Look From Yesterday to Tomorrow on the Building of Our Safety Infrastructure

Casey C. Grant, P. E.
Assistant Chief Engineer, NFPA International, Quincy, MA USA

Research to advance the cause of safety, and its implementation into the world of practitioners, is a noble venture that for the last one hundred years has been shared by the National Institute of Standards and Technology (NIST), the NFPA, and others. We can ably look back today and see a rich history of partnership and progress. It is our task to carry this same history into the future.

The way we interpret safety has changed over the last century, and it is dependant upon society's appreciation for the quality of life. Standardizing safety is a challenge. It inherently incorporates social, political, economic, and legal agendas into our efforts to provide technical conformity.

From Humble Beginnings

In the twilight of the 19th century, innovation and invention were propelling civilization to new dimensions.

Amidst the struggles of the working class and a population being bolstered by newly arriving immigrants, the late 1890's in North America were a time of dramatic change, growth, and opportunity. New technology was erupting everywhere, and it was in the face of great technological advances, or more appropriately the lack of consistency thereof, that a need for codes and standards and their administrating organizations began to solidify.

The year was 1901. Along with witnessing the founding of the National Bureau of Standards* (NBS), it was in general a banner time for codes and standards development. As the new century dawned, several organizations were emerging to join others that today comprise the backbone of the North American safety infrastructure.

The year 1901 saw the oldest standards developing organization in the United States, the U.S. Pharmacopeial Convention, observing their 81st year of service [1]. The ASCE (American Society of Civil Engineers) was preparing for their 50th anniversary celebration, while the ASME (American Society of Mechanical Engineers) was entering their 21st year. The IEEE (Institute of Electrical and Electronic Engineers) marked their 17th year of existence, and the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) had their 7th following their establishment in 1894. NFPA (National Fire Protection Association) was founded in 1896 and by the year 1901 had already become somewhat prolific with regard to its output of codes and standards. The National Electrical Contractors Association (NECA) was founded in 1901, and ASTM (American Society of Testing and Materials), which traces its founding to 1898, saw the year 1901 as a milestone as their first standard "Structural Steel for Bridges" was approved at their annual meeting.

Product certification practices were also evolving in 1901. This was the year that Underwriters Electrical Bureau, which was established in 1894 by William Henry Merrill, incorporated and changed their name to Underwriters Laboratories, Inc. William Merrill was also an integral participant in NFPA activities in these early days, where he served as the NFPA's Secretary-Treasurer from 1903 to 1908, and as President from 1910 to 1911.

The U.S. Federal Government was challenged during 1901 with the assassination of President McKinley in September. But despite this handicap, among the great achievements of that year was the action by Congress to establish the NBS, to support industry, commerce, scientific institutions, and all branches of government. In this role NBS has ably served as a foundation for progress to advance measurement science and support codes and standards development.

A Case Study in Partnership: The Great Baltimore Fire

It is clear that the safety infrastructure in the United States and elsewhere in the world has benefited significantly by the last century of NIST contributions. Although we can readily find countless examples, one of the earliest and somewhat colorful efforts was that involving the threads of fire hose, and this provides a distinctive illustration of how NIST has contributed directly to advances in safety.

* *The National Bureau of Standards* (NBS) revised its name to the *National Institute of Standards and Technology* (NIST) in 1988, and thus NBS and NIST is the same organization mentioned herein.

At the dawn of the 20th century, the industrial age had blossomed to new heights and the growth of urban centers in North America had increased dramatically. The most intense fire safety focus in those early days of the 1900's was less on individual building fire loss, and more on the sweeping conflagrations that would occasionally ravage the burgeoning cities of North America.

From one such conflagration came forth a loud cry for standardization. On Sunday, February 7, 1904, a fire broke out in the basement of the John E. Hurst & Company Building in Baltimore, Maryland. After taking hold of the entire structure, it began leaping from building to building. Before it was over, the fire had burned for more than 30 hours and destroyed approximately 2,500 buildings in an 80-block area located in the heart of the city [2].

The response from afar by the fire service was indeed noble. Apparatus was immediately dispatched by train from as far away as Washington, DC, Philadelphia, and New York to provide desperately needed firefighting reinforcements. Yet each municipality had its own unique threads for their fire hose, and consequently, their hoses could not connect to Baltimore's hydrant system and hoses, and they were forced to watch helplessly as the flames spread.

In the world of safety issues, it often takes a singular dramatic yet unfortunate event to bestow the societal mindset with a conviction to enact change. The lessons learned are typically hard lessons, and this was the case with the Baltimore Fire. Although the fire hose thread problem had been recognized for several years, it wasn't until the Baltimore conflagration that momentum finally solidified to take corrective action.

Shortly after the fire, the NBS received requests from the NFPA and others for assistance in resolving this important issue. As a result, the Bureau began a study of fire hose couplings, and over 600 couplings from across the country were collected and analyzed.

Based on the research provided by NBS, the NFPA adopted as national models in 1905 a standard hose coupling and an interchangeable coupling device for non-standard hoses [3]. Today, that document continues to serve this function as NFPA 1963, Standard for Fire Hose Connections, with requirements that provide a level of uniformity that is a direct factor in combating citywide conflagrations of this type [4].

Lessons in the Value of Human Life

In a world of standards, those dealing with safety go far beyond the spectrum of documents involved with marketplace conformity and trade facilitation.

In contrast, safety documents by their very nature typically restrict trade and freedom, but they do so to safeguard both an individual's safety and society's common good. Such documents can be powerful and far-reaching. All corners of civilization are often directly impacted, and the stakes can be very high. If poorly done, or not effectively implemented, the consequences may be extreme (i.e., serious injury or death).

Knowing that safety documents come in countless variations, it is useful to exemplify what might best be considered as the ultimate end of the safety document spectrum, that being the so-called "Codes." These model documents have traditionally evolved to be the caretakers of the premier societal mindset, and in this sense, they are entrusted with upholding the highest order of protection. Codes are typically written so that they can be adopted directly into law, and to reference numerous other more detailed technical documents. As such, their impact on all of society's constituents tends to be very significant.

When we talk about "safety," exactly what do we mean? We use this word regularly in the codes and standards world, and it has special significance in certain important regulations and agreements (e.g., GATT, General Agreement on Tariffs and Trade). But this is a somewhat elusive term that is relatively fluid, depending on how, when, and where it is applied.

With a focus herein on the field of metrology, one of the more intriguing challenges in the safety arena is that of the value of human life, and the measurement of this value. This may strike the casual observer as a difficult concept to comprehend, but it has been the subject of considerable study. As but one illustration of this point is the chapter in the *SFPE Handbook of Fire Protection Engineering* entitled "Value of Human Life [5]." Incorporating such quantifiable data into risk assessment calculations speaks clearly to what will likely be the norm with our approach to scientifically address safety issues in the future.

The High Cost of Fashion at Triangle Shirtwaist

It is convenient to take a closer look at another unfortunate disaster in our history, the Triangle Shirtwaist Company Fire. For North America, this was clearly a milestone event with respect to our collective attitude toward safety, and how this attitude can shift.

On Saturday, March 25, 1911, a disastrous fire erupted on the eighth floor of the 10-story Asch Building in New York City. The fire started on the premises of the Triangle Shirtwaist Company just as the workday was

ending. By the time this fire was extinguished several hours later, the top three floors were gutted, and 146 garment workers had perished either from the flames or by leaping from the top floors [6].

During the fire the adjacent streets were choked with a large crowd that witnessed this horrific scene. Further, this event also occurred at the height of the labor movement, and it became the tremendous catalyst that pushed the rallying cry of workers rights to new extremes. Public sentiment can best be characterized by the funeral parade that followed several days after the fire, where nearly half a million people attended the march despite a torrential downpour.

In the fire protection community, this fire was the turning point of the focus on safety, with safety for the community (i.e., mitigating citywide conflagrations) being overtaken by a new emphasis on the safety to life. Society was expressing itself that it was no longer acceptable for individuals to be injured or die in a setting like the workplace. This is a classic example of how safety is not simply a technical issue, but indeed it is inexplicably interwoven with social, political, economic, legal, and other agendas.

From a codes and standards perspective, the Triangle Shirtwaist Fire is a historical milestone because of the significant advances that arose from its ashes. While several individual's played a critical role in making this occur, one in particular is worthy of additional focus, Ms. Francis Perkins. Ms. Perkins was one of the individual's that stood in the crowd that tragic day and witnessed the Triangle Shirtwaist Fire. She eventually found herself as Secretary for the influential New York Committee on Safety, and at the NFPA Seventeenth Annual Meeting in May 1913 she was one of the keynote speakers.

The title of Ms. Perkins presentation was "The Social and Human Cost of Fire," and it evoked a stirring challenge to the NFPA to utilize its extensive network of public safety professionals to take action against such disasters [7]. From this was directly born the NFPA Safety to Life Project, responsible for NFPA 101, *Life Safety Code*®, that today is adopted and used in various forms by all 50 United States as well as numerous other governmental entities around the world [8].

Ms. Perkins would eventually become the first female cabinet member in the United States, when she was appointed Secretary of Labor under Franklin D. Roosevelt, and she held this office throughout FDR's entire four terms. The efforts of her and others have enabled far-reaching codes and standards activities like the *Life Safety Code*. Clearly, safety in the workplace in the United States had shifted. The so-called unavoidable or unpreventable accidents, which in many cases were once considered the result of inscrutable decrees of Divine Providence, had instead become viewed as the result of unscrupulous greed or human improvidence, and this was simply unacceptable.

A Century of Developing the Tools for Safety

NIST's contribution in providing a technical and scientific foundation for our safety infrastructure over the last one hundred years has been impressive. As outlined in a presentation at the 1977 NFPA Annual Meeting by John W. Lyons, former NIST Director from 1990-1993 and member of the NFPA Board of Directors from 1978-1984, the NIST Center for Fire Research has been intimately involved in all facets of the codes, standards, and practices aspects of the fire problem [9].

Fire is a complex phenomenon, and when we speak of safety in the built environment, our efforts to deal with the fire phenomenon are typically our greatest challenge. For example, the science of fire must address issues such as characteristics of ignition, combustion properties of materials, toxicology of products of combustion, and human behavior during an emergency event. Several noteworthy topics where NIST efforts have contributed directly to advances in codes and standards include research on: fire suppression methods; characteristics of products and materials; smoke detectors; fire safety in health care facilities; and fire modeling.

An event of particular note and which was responsible for numerous significant advances was the Federal Fire Prevention and Control Act of 1974. This was triggered by the landmark government study known as "America Burning [10]." Then Secretary of Commerce Frederick B. Dent was one of the Commissioners of this report, and it provided direct enhancements to our safety infrastructure whose benefits are still being realized today.

Great strides have been made in developing the scientific tools to better understand this phenomenon, and NIST has been a clear leader in this effort. Yet certainly, there is still much work to be done. Despite our progress, death, injury, and destruction of property from fire in the United States and throughout the world remains today as a significant burden on civilization.

The Role of Safety in Today's Global Community

The Triangle Shirtwaist Fire provided a useful case study to exemplify how society can shift its perception of safety over time. However, safety is also dependent on the cultural attitudes that typically differ from one country to the next.

Another case study usefully portrays this concept. For 82 years, the world has recognized the Triangle Shirtwaist factory fire as the worst accidental loss-of-life industrial fire in which fatalities were limited to the building of origin. Then, on May 10, 1993, the Kader Toy Factory Fire in Thailand superseded this dubious recognition when 188 workers perished [11].

The details surrounding the Kader Fire have striking similarities to the Triangle Shirtwaist Fire. Today, Thailand is similar to other developing nations in that they are attempting to balance booming economic growth with workplace safety. Countries that are more developed, meanwhile, have a safety infrastructure that is likewise more established, and although disasters still occur, they generally do not have the grotesque violations of safety principles that are often seen in the nations that are coming-of-age. It is as if certain disasters must be experienced first-hand before their respective safety infrastructures can effectively address them.

When we speak of the safety infrastructure, it is more than simply well-written codes and standards, since achieving the ultimate goal of safety also requires adequate inspection and enforcement by the local authorities. With this and other reasons, it is clearly difficult to take a single prescriptive safety code or standard and apply it realistically in different countries, especially where concepts of safety vary. Enter the performance-based approach.

A true performance-based code has the flexibility to be used in any particular jurisdiction, and it is resilient to the local mindset of how "safe is safe." With flexibility to justify protection based on the available resources and the local societal risk tolerance, a performance-based approach delivers a controlled mechanism to realistically implement the latest state-of-the-art scientific tools (e.g., fire modeling).

Today, building codes around the world have been transitioning to a performance-based approach. The NFPA Life Safety Code mentioned earlier has a full performance-based option, and the new NFPA Building Code will likewise have such a performance-based option.

Challenges of Tomorrow

So what safety challenges do we face with tomorrow's built environment? Although the advances in safety techniques and scientific research will equip us well for the work ahead of us, the challenges themselves will likewise become more enhanced.

On the subject of technological advances, the smart building design of tomorrow is fast becoming a reality. With new building system protocol languages such as BACnet and Lonworks, the fire safety systems will soon be integrated with the building systems involving security, transport (e.g., elevators and lifts), environment (e.g., HVAC), and so on [12]. Such integrated buildings can be expected to function more efficiently, but they also present new challenges to assuring a safe and reliable building for both the occupants and emergency responders.

Meanwhile, today's world presents challenging safety applications that were unimaginable 100 years ago. For example, consider applications such as a genetic research laboratory, a jumbo aircraft manufacturing plant, or a facility handling high-powered lasers. Such applications raise the question of what the next 100 years will bring. For sake of discussion, consider the following unusual constraint of physical handicap that challenges today's safety professional. These are all real applications, each having required real innovative safety designs for fire and other hazards:

> temperature extremes on an offshore oil drilling platform; lack of electrical interference in an anechoic chamber; highly purified air flow in a clean room facility; environmental containment for a genetic research laboratory; zero gravity in a space station; process purity in a molten salt bath; or oxygen enriched atmosphere in a space capsule simulator.

As we discuss the challenges of tomorrow's world, we can see that providing a safe environment is becoming more challenging for several reasons. Consider first, how *property value densities are approaching levels beyond rational comprehension.* Equipment that does more today is occupying a fraction of the space it used to. Certain facilities today have equipment with unimaginable property values per the area that it occupies.

One of the more extreme examples of the possible concentration of value was exemplified by the recent polyolefin manufacturing plant disaster in Pasadena,

Texas on October 23, 1989 [13]. A massive vapor cloud explosion that killed 23 workers and resulted in a dollar loss of an estimated $750,000,000 (U.S. Dollars) destroyed this plant. With inflation taken into account, this single facility disaster was the fourth largest fire loss in U.S. history when it occurred, behind the San Francisco Earthquake of 1906, the Great Chicago Fire of 1871, and the Great Boston Fire of 1872. It raises the question of when we will see the first billion-dollar fire loss from a single facility.

Second, *certain facilities exhibit typically high levels of sensitivity to fire and smoke damage.* For instance, a moderately sized fire of a certain magnitude and smoke generation occurring in a sheet-metal machine shop would result in far greater damage if it instead occurred in a semiconductor clean room.

An incident that occurred in a telephone substation in Hawaii during 1982 exemplifies the sensitivity of today's high-tech equipment [14]. This small facility experienced a relatively small fire resulting in a high property value loss. The remote one story building was approximately 40 feet by 50 feet, and had no automatic fire protection systems protecting the several telephone terminal racks contained within. Following arrival by emergency responders, which was delayed by lack of telephone service, personnel quickly extinguished the fire using two carbon dioxide portable extinguishers and one dry chemical extinguisher. Despite a fire that was relatively small and easily extinguished, the dollar loss for this large-loss fire was set at $2,300,000.

Third, *as technology becomes more advanced, society becomes more dependent upon this technology.* And as society becomes more dependent, it also becomes less tolerant of a loss. Consider the traditional indirect losses associated with a typical major disaster, such as loss of jobs, or loss of taxes to a community. Today, the indirect losses can be more far-reaching, with an impact on large segments of society.

Exemplifying this point is another incident involving a telephone switching station, though this time located in Illinois and occurring in May 1988 [15]. The estimated dollar value loss for this fire was $50,000,000, but most significant was the indirect loss associated with lack of telephone service. Significant portions of the Chicago area were left with limited service for various periods of time. Community dysfunction included national reservation centers becoming disabled, O'Hare and Midway Airports being shutdown due to effects on the flight control system, a hospital complex losing all internal and external telephones, and various other tales of how losing this technology affected many, many people.

Fourth, *new technologies create different and sometimes highly unusual hazards.* In contrast to the previous point that focused on society's suffering because of an event that took away something they depended on, this point is based on a disaster introducing a new and unusual hazard of some kind.

Consider the impact that arises when a minor crisis creates damage of little direct importance but is indirectly devastating because it unleashes a much greater hazard of another type. The nuclear facilities of the electric power industry provide an example of this thought, where the greatest impact can be damage to the safety or control mechanisms that prevent a radiation hazard. For example, in March of 1975 a serious fire occurred at the Browns Ferry Nuclear Power Plant in Alabama [16]. Even though no radiation was released from this seven hour cable fire, very significant concerns were raised afterwards over the possibility of a core meltdown in the nuclear reactor due to potential loss of reactor coolant. The societal ramifications of a core meltdown with radiation release, neither of which fortunately occurred, could have been immense.

Carrying this same thought further, some losses are devastating in terms of their primary effects rather than secondary effects. Today there exists an enhanced potential for extremely rapid hazard development on an unprecedented vast scale. For example, a fire in a rocket fuel manufacturing plant in Nevada during May 1988 resulted in an explosion that left a 400 foot crater and registered 3.2 on a Richter scale 200 miles away [17]. Of the estimated $103,000,000 loss, $27,000,000 was attributed to the originating facility and $76,000,000 was based on damage to exposures. Another example was an explosion at a LP-Gas distribution plant just outside Mexico City that occurred in November of 1984 [18]. This tragic incident impacted a nearby residential neighborhood with over 500 deaths, 7,230 injuries, and 60,000 people displaced from their homes.

Although the incidents mentioned above are some of the more exotic examples of our brave new world gone awry, the challenges of safe design arise just as frequently in what are seemingly mundane occupancies, whether the physical complexities of a high-rise hotel atrium, security concerns at an airport terminal, or making built-in safety protection measures unseen at a museum. The lessons from the past provide stark recognition that the hazard applications of tomorrow demand special attention.

Welcoming a Second Century of Partnership

We have seen examples of how our interpretation of safety has changed over the last century, and how it inherently incorporates social, political, economic, and legal agendas into our efforts to provide technical conformity.

The positive impact upon society from safety documents and "codes" is often underestimated, and the resources and diligence required to develop and maintain these documents is, at best, daunting. How well do we appreciate, for example, the implications of the proposed ISO project on Occupational Health and Safety Management Systems, which continues to be considered and whose establishment seems imminent if current trends continue? The social and political agendas that are inherently part of the rights of workers are indeed profound, and these will undoubtedly be a factor in this activity.

To further illustrate this point, one industry-sector specific NFPA activity addressing Firefighter Occupational Health and Safety received over 22,000 public comments. Any foray into this arena should be expected to have high levels of interest and passion. We certainly want to raise the "level of safety" in industry-sectors or countries that are substandard, but under no conditions do we wish to simultaneously sacrifice the higher "level of safety" that certain constituents are fortunate to have already established. This is indeed a challenge.

Today, the majority of codes and standards addressing safety in the built environment, and especially fire safety, are shifting from pure prescriptive to now include a performance-based option. NFPA 101, *Life Safety Code,* mentioned earlier as one of the documents that resulted directly from the Triangle Shirtwaist Fire, recently underwent a complete transformation and its latest edition provides a useful example of a full performance-based approach.

Prescriptive-based documents can be traced back to the 19th century when major conflagrations created the need for specific building provisions. Revisions over the years resulted primarily from significant events that revealed deficiencies, and this has created codes based on empiricism and experience, rather than a scientific understanding of fire. Many scientific advances in safety have been made in recent times, but attempts to incorporate them into everyday practice are on-going. Performance-based codes and standards will promote freedom to develop appropriate and cost-effective building designs and bring safety to optimum levels.

NIST has played a crucial role in our current progress, and now their role only increases in importance. The research stability offered by NIST has contributed greatly to today's foundation of progress, and our direction toward performance-based documents speaks loudly toward the need for NIST's contribution to make a fire safe tomorrow. Together, with NIST, we can succeed as we continue "putting safety first."

References

[1] Toth, Robert B., *Standards Activities of Organizations in the United States,* NIST Special Publication 806, National Institute of Standards and Technology, Gaithersburg, MD, 1996.

[2] Lyons, Paul Robert, *Fire in America,* "Baltimore—Simply a Matter of Unmatched Threads," NFPA, Quincy, MA, pp. 122-123, 1976.

[3] Griswold, F.M., *Report of the Committee on Standard Thread for Fire Hose Couplings, Proceedings of the 9th NFPA Annual Meeting,* New York, May 23, NFPA, Quincy, MA, 1905.

[4] NFPA 1963, *Standard for Fire Hose Connections,* NFPA, Quincy, MA, 1998.

[5] Ramachandran, G., *Value of Human Life, The SFPE Handbook of Fire Protection Engineering,* Section 4/Chapter 9, 1988, p. 4-74.

[6] Grant, Casey Cavanaugh, *Triangle Fire Stirs Outrage and Reform, NFPA Journal,* NFPA, Quincy, MA, May/June 1993.

[7] Perkins, Francis, *The Social and Human Cost of Fire, Proceedings of the 17th NFPA Annual Meeting,* New York, May 13-15, NFPA, Quincy, MA, 1913.

[8] NFPA 101, *Life Safety Code®,* NFPA, Quincy, MA, 2000.

[9] Lyons, John W., *The Role of the National Bureau of Standards in Private Sector Fire Prevention Activities, Proceedings of the 81st NFPA Annual Meeting,* Washington, DC, May 16-19, NFPA, Quincy, MA, 1977.

[10] *America Burning,* The Report of the National Commission on Fire Prevention and Control, U.S. Government Printing Office, Stock Number 052-000-00004-1, Washington, DC, 1973.

[11] Grant, Casey Cavanaugh, *Case Study: The Kader Toy Factory Fire, ILO Encyclopaedia of Occupational Health and Safety,* Vol II, Part VI, Section 39 Disasters: Natural and Technological, International Labour Office, Geneva, Switz., pg. 39.41, Fourth Edition, 1998.

[12] Grant, Casey Cavanaugh, *Latest Developments for Fire Detection and Suppression Applications,* technical presentation at Plenary Conference of the Confederation of Fire Protection Associations, Cairo Egypt, March 1999.

[13] Taylor, Kenneth T. and Tremblay, Kenneth J., "A Year for the Books," *NFPA Fire Journal,* November/December 1990, National Fire Protection Association, p. 45.

[14] LeBlanc, Paul and Redding, Donald, "1981 Large-loss Fires in the United States," *NFPA Fire Journal,* September 1982, National Fire Protection Association, p. 48.

[15] Isner, Michael S., "Fire Investigation Report on Telephone Central Office, Hinsdale, Illinois, May 9, 1988," National Fire Protection Association, 1990.

[16] Sawyer, R. G. and Elsner, J. A., "Cable Fire at Browns Ferry Nuclear Power Plant," *NFPA Fire Journal,* July 1976, National Fire Protection Association, p. 5.

[17] Taylor, Kenneth T. and Tremblay, Kenneth J., "Large-loss Fires in the United States During 1988," *NFPA Fire Journal,* November/December, 1989, National Fire Protection Association, p. 63.

[18] Johansson, Odde, "The Disaster at San Juanico," *NFPA Fire Journal,* January 1986, National Fire Protection Association, p. 32.

Additional Reading

Bugbee, Percy, *Men Against Fire, The Story of the National Fire Protection Association,* NFPA, Quincy, MA, 1971.

Cohn, Jeff, *Firesafety Research at NBS, Fire Journal,* NFPA, Quincy, MA, p. 75, November 1982.

Custer, Richard L.P., Meacham, Brian J., *Introduction to Performance-Based Fire Safety,* NFPA, Quincy, MA, 1997.

Gill, P., Lowell, S., Vaughan, W., *Participation by Federal Agencies in Voluntary Consensus Standards Bodies, Standards Engineering, The Journal of the Standards Engineering Society,* Vol. 52, No. 6, November/December 2000.

Grant, Casey Cavanaugh, *The Birth of NFPA, NFPA Journal,* NFPA, Quincy, MA, March/April 1996.

Grant, Casey Cavanaugh, *What Makes an Industry High-Tech?, NFPA Journal,* NFPA, Quincy, MA, pg. 32, March/April 1992.

National Bureau of Standards, *Crosby-Fiske-Forster Handbook of Fire Protection,* 9th Edition, NFPA, Quincy, MA, p. 23, 1941.

Newbern, R. H., *Suggestions for the Organization and Execution of Fire Drills in Factories, Schools, Department Stores, and Theatres,Proceedings of the 16th NFPA Annual Meeting,* Chicago, May 14-16, NFPA, Quincy, MA, 1912.

NFPA Fireman Magazine, NFPA, Quincy, MA, 1964.

NFPA's Future in Performance-Based Codes and Standards, Report of the NFPA In-House Task Group, NFPA, Quincy, MA, July 1995.

NIST at 100, Foundations for Progress, NIST Special Publication 956, National Institute of Standards and Technology, Gaithersburg, MD, October 2000.

Oksala, Stephan, *The Changing Standards World: Government Did It, Even Though They Didn't Mean To, Standards Engineering, The Journal of the Standards Engineering Society,* Vol. 52, No. 3, May/June 2000.

Resolution Commending the Services of the U.S. Department of Commerce, Proceedings of the 34th NFPA Annual Meeting, Atlantic City, May 12-16, NFPA, Quincy, MA, 1930.

Putting Safety First

A Look from Yesterday to Tomorrow on the Building of Our Safety Infrastructure

Casey C. Grant, P.E.
NFPA International

SLIDE 1

From Humble Beginnings

- *Life at the turn of the century*
  - *The Industrial Revolution / Gilded Age*
  - *Tremendous growth in North America*
- *NIST (NBS) created in 1901*
  - *Coming of age of the safety infrastructure*
  - *Other organizations established*

SLIDE 2

A Case Study in Partnership: The Great Baltimore Fire

- *The Great Baltimore Fire of 1904*
  - *Sunday 7 February 1904*
  - *Destroyed 2,500 buildings; 80 city blocks*
  - *Burned 30 hours*
  - *Assistance from as far away as Philadelphia and NY City*

SLIDE 3

A Case Study in Partnership: The Great Baltimore Fire

- *Problem:*
  Lack of a common fire hose thread
- *NBS worked directly with NFPA*
  - *Study of more than 600 different couplings from across U.S.*
- *Progress in standardization*
  - *Direct impact on city-wide conflagrations*
  - *Results still realized today*

SLIDE 4

Lessons in the Value of Human Life

- *"Safety": What is it?*
  - *Mentioned in important treaties and procedures*
  - *Not clearly defined*
- *The concept of measuring the value of human life*

SLIDE 5

Lessons in the Value of Human Life

Concepts of "Safety"

- *Balance of society's:*
  - *Tolerance to risk*
  - *Willingness to commit resources*
- *Example: Hi-Rise Sprinkler Systems*

SLIDE 6

The High Cost of Fashion at Triangle Shirtwaist

- Asch Building: Triangle Shirtwaist Fire
  - Saturday, 25 March 1911, in NY City
  - 10 story loft factory
  - Fire in top 3 floors
  - 146 fatalities, mostly young female garment workers

SLIDE 7

The High Cost of Fashion at Triangle Shirtwaist

- Triangle Shirtwaist Fire:
  - A milestone event in the advance of life safety
  - Focus from large scale conflagrations to safety of building occupants
- Establishment of Code on Exit Drills:
  - NFPA 101 Life Safety Code created

SLIDE 8

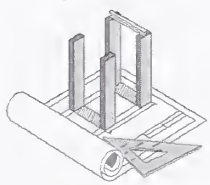
A Century of Developing the Tools for Safety

- Development and implementation of the tools making the world a safer place
  - Working together over the last 100 years
- NIST's role in the safety infrastructure
  - Federal Fire Prevention and Control Act of 1974

SLIDE 9

The Role of Safety in Today's Global Community

- Case study comparison:
  - The Kader Toy Factory & Triangle Fires
  - Yesterday (1911) vs. today (1993)
  - Developing vs. developed regions
- How safety differs based on societal location and culture



SLIDE 10

Challenges of Tomorrow

- A changing landscape:
  - The advent of smart building design
- New challenges of extreme hazards:
  - The high tech world of today & tomorrow
- Facing the challenge:
  - Future of prescriptive documents
  - Advantage of performance based approaches

SLIDE 11

Welcoming a Second Century of Partnership

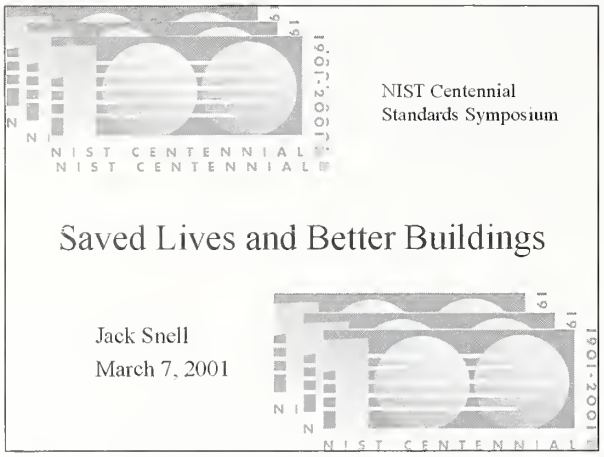
- Design tools for a better tomorrow
  - Safety based on predicting building performance
- Foundation for progress:
  - Working together to make the world a safer place

SLIDE 12

Saved Lives and Better Buildings: Technical Contributions That Make a Difference

Jack Snell
Director, Building and Fire Research Laboratory, National Institute of Standards and Technology

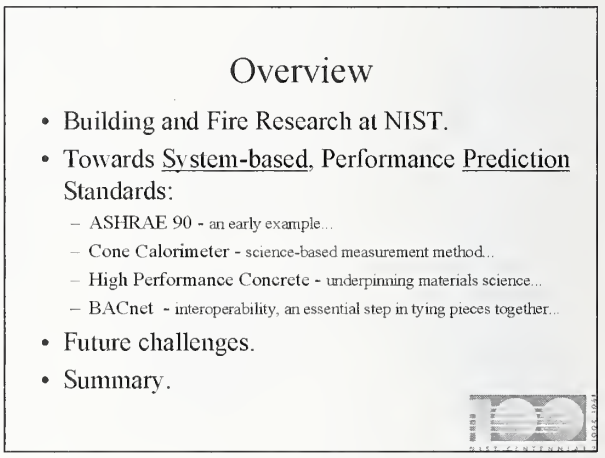
INTRODUCTION



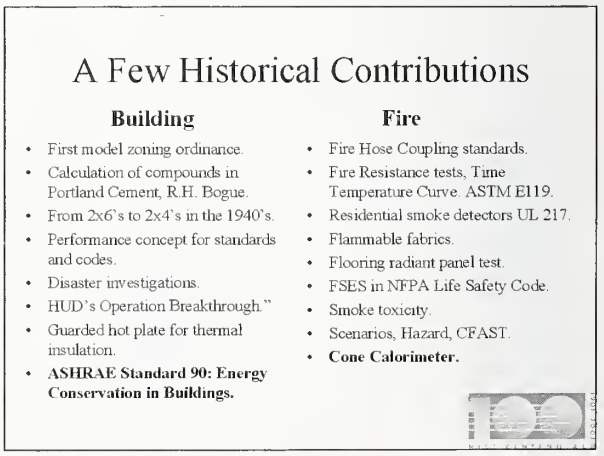
SLIDE 1

It is indeed an honor to have the opportunity to participate in this NIST Centennial Standards Symposium. I, like many of you, was engaged by Larry Eicher's war games model this morning, a Standards War Game. My talk deals mostly with the second and third columns, situations where there are either wasteful or dangerous implications to our interactions. The issues at stake in many of the building and fire safety standards that we deal with are just that: matters of either public health or safety, and often life safety. I also want to focus on the last two of the principles in the national standards strategy in your handout package, and in particular on the bottom of page 4. One deals with the phrase, "Use of current available technology," and the last principle addresses performance-based standards. My point is that I don't think that either of these statements goes anywhere near far enough in describing what, in fact, needs to be done to respond to the mounting pressures for globalization on the one hand, and standards and practices that reduce costly wastes and losses—often involving loss of life and injury—on the other.

As Mathias pointed out earlier this morning, yes, there are political and economic, as well as technical issues at work in standardization. Yet, in a highly competitive global economy, all of the players are challenged to deal responsibly with the best available tools for each of these three elements; technology, economics, and politics. This capability does not come without a price. In my view, he who is willing to pay it is most likely to be the winner in Larry's game. By way of overview, (Slide # 2) I want to say first a few words about building and fire research at NIST, and then use four examples which punctuate the need for systems-based performance prediction standards. I will close with some thoughts about future challenges. (Slide # 3) NIST work in fire began not just with the hose coupling issues in the great Baltimore fire, but also because the same issue arose in a fire on the NIST campus within the same year. I guess that was probably our first war



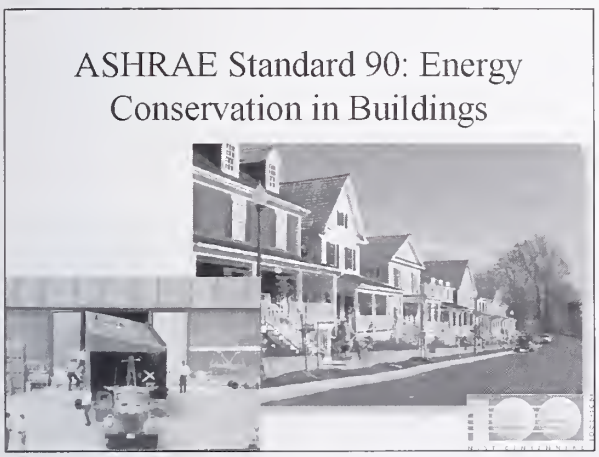
SLIDE 2



SLIDE 3

game in the standards business. NIST authored the first model zoning ordinance in the early decades of the century, and has gained public attention over the years for a number of our disaster and fire investigations. Two of the more recent examples I wish to highlight are listed on the bottom of this slide: ASHRAE Standard 90 and the cone calorimeter.

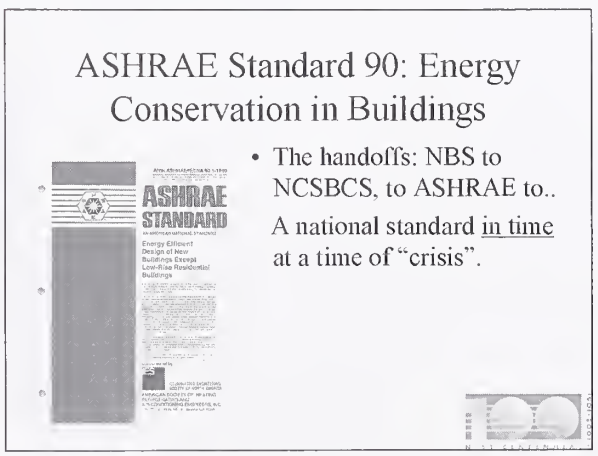
My first example is ASHRAE Standard 90. (Slide # 4) This has to do with the subject of energy conservation in buildings. You may recall that in the early years of the 1970s we faced an energy crisis that was stimulated by activities in other parts of the world, and something had to be done about it, and done in a relatively short period of time. As it turned out, about one-third of energy consumption is used in houses.



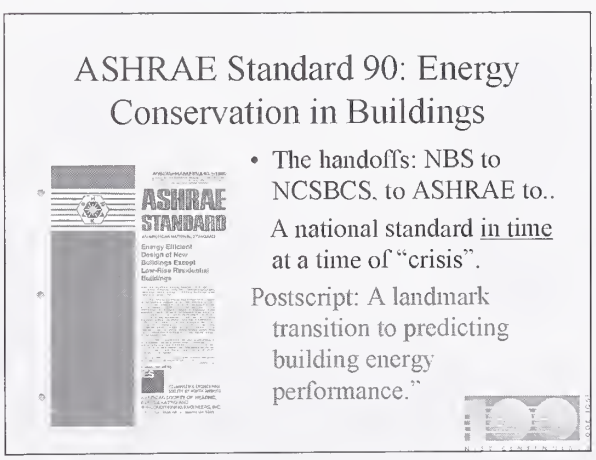
SLIDE 4

NIST WORKING ON FIRST GENERATION MODELS

Now, NIST had been working in the 1960s on first generation models of building energy performance. This was represented in Dr. Tamami Kusuda's "National Bureau of Standards Load Determination," or NBSLD computer model for the thermal energy flows through the envelope of a building. Shown here in the picture on the left is one of three modules of a factory built townhouse that was used for full-scale verification of that computer program, the results of which were published in 1975. Now, during that time in 1973, NBS was approached by the National Conference of States on Building Codes and Standards to develop guidelines home builders could use in helping reduce the impact of this critical sector on the national energy budget. Reece Achenbach, Chief of the Building Environment Division, pulled together a team to develop such a guide, drawing on the division's long-term expertise in prediction and measurement of building thermal performance and lighting. The resulting product was issued in February of 1974, and entitled, "Design and Evaluation Criteria for Energy Conservation in New Buildings." (Slide #5) The National Conference of States delivered the NBS product to the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE), and they in-turn converted the guidelines into a national standard in the following year! Also, as soon as that was done, ASHRAE set up a national program to train trainers. ASHRAE then set up training in each ASHRAE Chapter throughout the country so that within a number of months practicing heating, ventilation, and air- conditioning engineers all around the country were using this document. Thus, in less than 2 years, (Slide # 6) a national standard was developed, disseminated, and actually put into widespread use, saving energy in a time of public need. Had NBS not been working on the underpinning science and technology in the previous decade, it would have taken years instead of months to deliver such a document. Because we pushed the envelope and embraced best, as well as available, technology, these models are still in use today and much of the science is being enhanced.



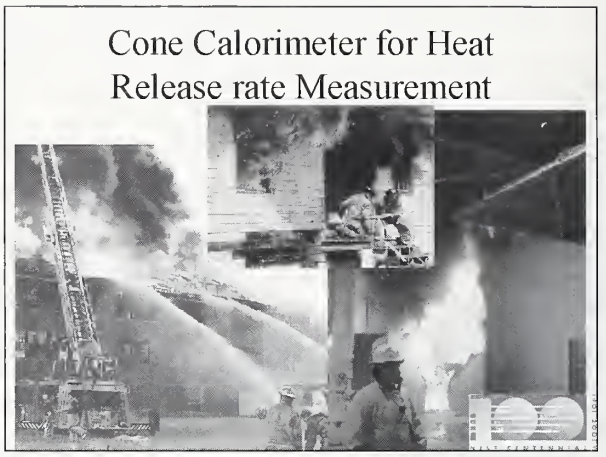
SLIDE 5



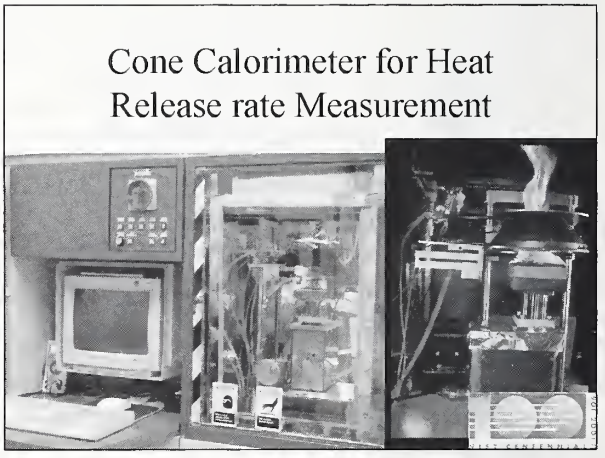
SLIDE 6

The next example that I want to talk about (Slide # 7) deals with the troublesome problem of building fires that Casey Grant talked about earlier. In the early 1980s, U.S. fire deaths were still on the order of 5,000 and the U.S. fire death rate was one of the highest in the world. Now, by that time, a serious program of fundamental fire research was underway at NBS, initiated through the foresight of John Lyons in the 1970s, that began to produce, for the first time, insights into why building fires grow so big so fast. For example, a single couch or set of easy chairs could turn a room into an inferno within 2 or 3 minutes. The reason for this is that much of the energy released in such a fire is in the form of radiation, which when confined, feeds back to the unburned fuel, thus accelerating the process of burning at an exponential rate. Thus, a critical factor in the flammability of a material is its rate of heat release. This is a measure of how rapidly it will decompose into combustible gases and burn when heated by a radiant source. This knowledge—and the scientific insight of chemist, Clayton Huggett—that the amount of oxygen consumed in the combustion of most polymeric materials is a constant—led to the development of a novel approach to measuring rate of energy release. (Slide # 8) Shown on the right-hand side is the original cone calorimeter for rate of energy release measurement as developed by Vytenis Babrauskas. The principle of operation was simple. A conical shaped heater projects a prescribed amount of energy on a sample, and the combustion products rise through a hood and into a tube where oxygen levels are monitored continuously, and a load cell under the sample measures mass loss as the sample is pyrolized or burns. These measurements then provide the oxygen consumption and mass loss needed to determine the rate of heat release as a function of time. This principle of measurement has been codified in ASTM and ISO standards, and embodied in commercially produced apparatus such as the one shown on the left, and are now used world-wide for this critical flammability measurement.

There are two important consequences of this work. First, this measurement approach can be used for measurement of rated heat release of fires of any scale where it is possible to capture the combustion products in a collection hood. Secondly, (Slide # 9) the rate of heat release is a property of the response of the material to radiation, so that such calorimeters provide essential data for modeling fire and fire growth in computer-based models and simulations, such as the fire dynamic simulator illustrated on this slide. Here again fundamental fire research, addressing the very mechanisms of burning, was a necessary precursor to the more practical applied tools that came later.



SLIDE 7



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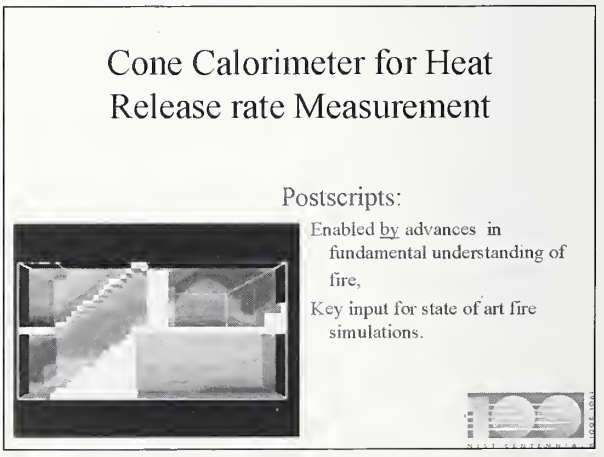


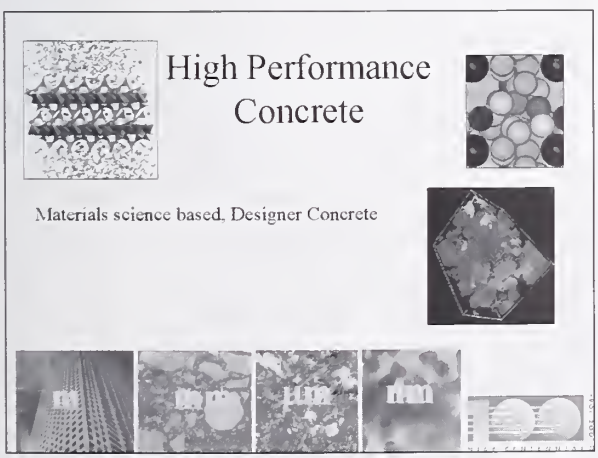
SLIDE 9

My third example deals with concrete, which, along with steel, is a ubiquitous building material of choice for most infrastructure (Slide # 10) and the built environment. In recent years, fundamental research on concrete has produced knowledge to design "high performance concretes," which will last up to 10 times longer, and have strengths as much as 3 to 5 times greater then those in common use today. However, nagging issues about the performance of these materials remain. (Slide # 11) For example, concrete has been plagued with a number of problems that lead to early failures such as spalling. Spalling is not only an unattractive appearance issue, but also consequent failures can lead to fatalities as well. This is unacceptable. Why is it that in some applications concrete seems to last forever; whereas in others it begins to spall and come apart within a few years of use? How can concrete be used reliably if this is the case? Well, here again fundamental research has been the key. Partnering with industry, we have advanced the state-of-the-art understanding of the mechanisms of strength gain, and failure, such as sulfate attack, as in the case shown here resulting from salt exposures.

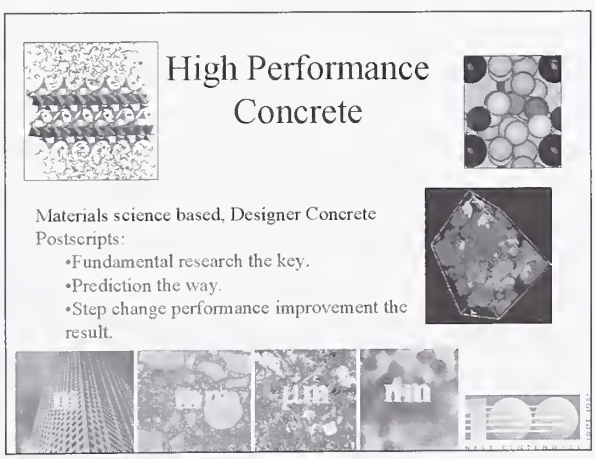
Concrete really is a very highly complex system, (Slide # 12) whose properties at the meter scale depend on relevant mechanisms at the milli, micro, and nanometer scales, as illustrated on the bottom of this slide. Just above that, on the right, is an image from a computer simulation of water movement in a hydrating cement specimen, and above that, in the right-hand corner, is an image from a model of concrete rheology. Finally, on the left is an image from a molecular dynamics model of reactions near the surface in a hydrating cement. This scientific, state-of-the-art knowledge is now enabling reliable performance and service life prediction for such materials. (Slide # 13) As a consequence of not having to mix concrete by trial and error, as an art, designers are now beginning to be able to design for specific needs of particular applications, and to predict performance reliably. Once again, fundamental research, leading to advances in measurement and prediction technology, is enabling powerful new capabilities for design and application. The consequences will be seen in coming decades in bridges and highways that are not subject to failure from

SLIDE 10

SLIDE 11



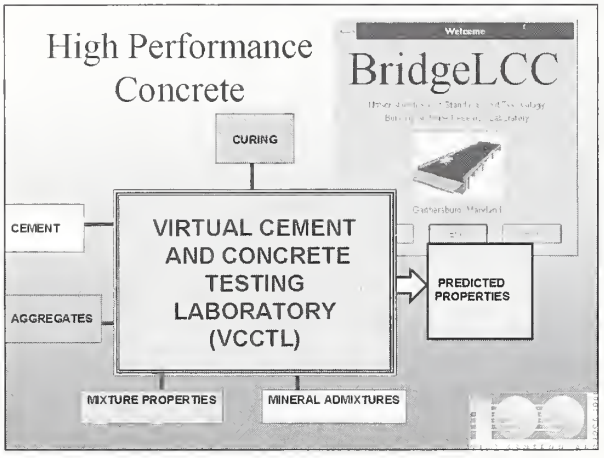
SLIDE 12



SLIDE 13

salt, to airport roadways, dams, and buildings that can be built better, faster, safer, and at lower cost.

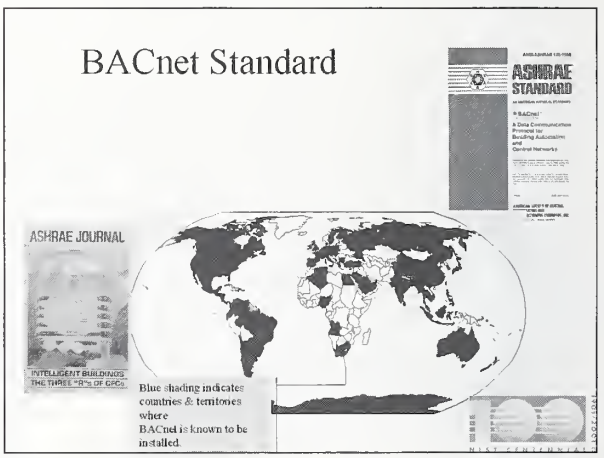
Just as an aside, (Slide # 14) our folks recently established with partners in industry a virtual cement and concrete testing laboratory (VCCTL). This web-based facility, for example, will enable users to replace the old 28-day strength test by predictions made from three-day tests. Three days instead of 28! Just think of the cost savings in delay time on construction sites. Also, such tests cost about $300 each, and a good sized concrete firm will make thousands of such tests a year. Now we are talking about real significant dollar savings.



SLIDE 14

My fourth example (Slide # 15) is a standard for interoperability of the hundreds of elements used in building control systems. This has been an issue in building mechanical systems, as it has been elsewhere, in the worlds of electronics and computing, and it points to the benefits of open systems. NIST, in partnership with a number of foresighted companies and the American Society of Heating, Refrigeration, and Air-Conditioning Engineers, developed the BACnet standard for interoperability for such systems. That standard was introduced in 1996 at the ASHRAE show (as shown in this slide) where the products of 13 companies were interconnected using the BACnet protocol. Today, (Slide # 16) just a few years later, there are some 77 registered BACnet products from some 15 member companies of the BACnet Manufacturers Association. Just six of those firms have installed over 300,000 devices in some 20,000 installations in 82 countries across the world. This is real leverage and impact. (Slide # 17) Now, this has not been an easy trip, and it did involve a standardization war of a sort. At the start, as you might imagine, some of the big guys were reluctant to participate. Now they all want in. As usual in innovation, there was a tension between public knowledge and corporate advantage. Yet when all is said and done, and the new technology is in place, there are great new market opportunities for all.

SLIDE 15



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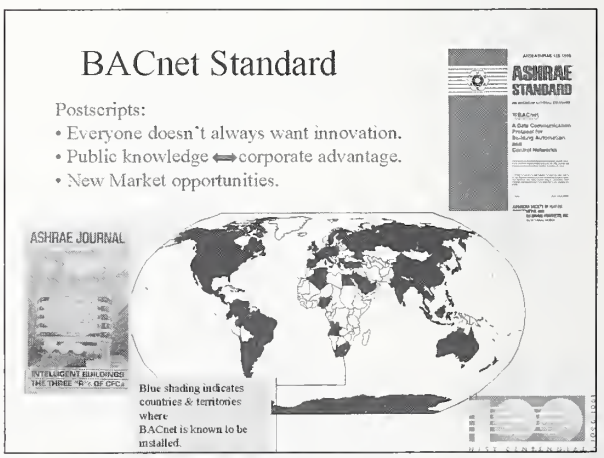
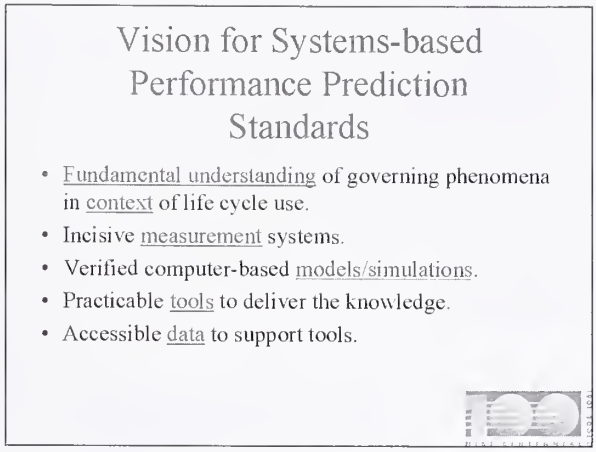


SLIDE 17

These four examples lead me to the main point of my remarks, and that is that the national standards strategy is great, as far as it goes. (Slide # 18) And yet we must not be content with currently available technology or simplistic notions of, typically component, performance-based standards. Each of the examples I described dealt with applications of fundamental knowledge to measurement and prediction of system performance in the context of life cycle use. What the end-user desperately needs is knowledge of real performance through the life cycle of the product or design in the context of actual use. Our vision in the Building and Fire Research Laboratory is to provide the scientific and technological capability to do just this. Inescapably, real performance-based standards require all of the things listed on this slide. Yet, despite all of the advances that I have described, in most aspects of building performance, current knowledge remains woefully insufficient to be able to do these things. The sad fact is that in many countries and laboratories traditional and empirical tests are passed off as performance tests and most existing performance standards fail to match the vision I just outlined. That is, they are not taken in the context of actual life cycle use for the product or design, nor do they actually predict end-use performance. (Slide # 19) Even worse, few building research laboratories still do real research aimed at fulfilling this vision. Most of our counterparts around the world have been privatized and are mostly consultancies or doing commercial product testing to the limit of their capabilities. Make no mistake about it. There will be no meaningful performance standards that do not meet the criteria of quantifying the real benefits of better quality or of value added. In a highly competitive global economy, who wants to settle for a standard that simply benchmarks against the legal minimums? What incentive does that offer for innovation or for new products? If no one is doing the research, who will verify the new tools and models? (Slide # 20) If most facilities are used for commercial product testing, who will do the real scale tests or come up with the funds for such costly tests? Only state-of-the-art scientific measurement systems, with known accuracy and measured uncertainty can be used for such an undertaking. As a footnote, none of the fire labs in the world today are even capable of uncertainty measurement in fire tests.

Models need maintenance and vast quantities of data. (Slide # 21) Who is going to provide this data? Who will affirm its quality, and who will maintain objectivityin the use of it? (Slide # 22) Clearly, each of



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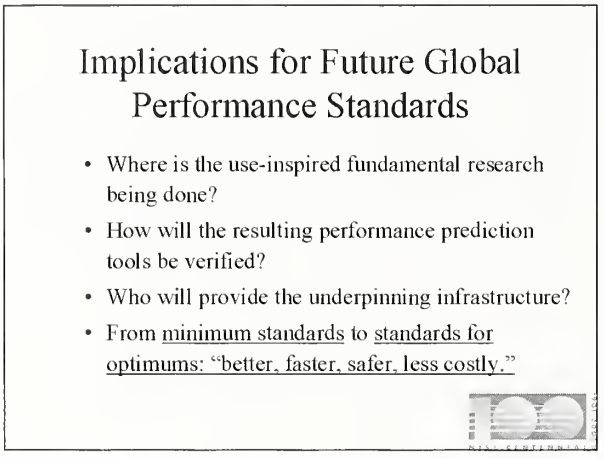
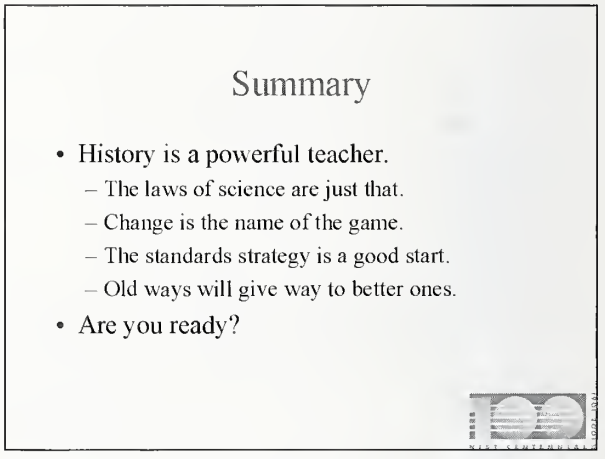


SLIDE 22

these questions needs to be addressed to reach the goal of practicable systems- based performance prediction standards that are based on best available technology. Once they are in existence, the payoff is tremendous to the consumer and to innovative product producers. The result is better, faster, safer, and less costly buildings and facilities. (Slide # 23) The bottom line, as we all know, is that there is no free lunch. Yes, science, economics, and politics are different, and one is no substitute for the other, especially in an open and highly competitive marketplace. It has been said that if you build a better mouse trap the world will beat a path to your door, and this may well be true, especially if you have a way to demonstrate in quantitative terms meaningful to the buyer that what you have is indeed better. If not, others will, and in the end they will get the business. Let's not lose it.



SLIDE 23

Standards Partnerships

100 Years of NIST and ASME Public/Private Partnering

June Ling
Associate Executive Director, Codes and Standards, ASME International

I would like to thank NIST for the opportunity to speak today in commemoration of their 100 years of partnering with the private sector technical and standards developing community.

In preparation for this Symposium, I looked into ASME's records and found that on Thursday, September 27th of the year 1900, ASME's governing body took an action which essentially read:

> *Resolved, that a committee of five be appointed by the chair to take such action as may be necessary in co-operation with the other national societies of kindred aim, with reference to the creation of a Bureau of Standards such as proposed by the action of the American Chemical Society . . . and the Institute of Electrical Engineers.*

Less than six months later, on March 3, 1901, the National Bureau of Standards was chartered by the U.S. Congress. Now, unless Congress worked a lot faster than it does today, one can only surmise that these scientific organizations of "kindred aim" lent their support to a concept which was already in play—but it was the beginning of a century long partnership between NIST and the private sector community.

To realize the import of the establishment of the National Bureau of Standards, one needs to think of what life was like back in those times. At the turn of the previous century, the United States was still essentially a union of individual states. Public safety and interstate commerce were governed by a multitude of differing state and local ordinances. The industrial age was upon us and yet there was little or no standardization nor interchangeability of parts; and at an even more fundamental level there were no accurate standards of weights and measures. It was a time of rapid industrial growth "driven by the steam engine, the railroad, and the expanding reach of electricity" [ref. NIST at 100].

Standards

The establishment of national standards for electrical measurement, as well as length, mass, temperature, light, and time were essential to the industrial growth of this nation and its ability to provide for fairness in the marketplace. In the publication "NIST at 100," it states that "Measurements have a symbiotic relationship with science and technology. They depend on each other, and if one advances, the other does too." How true a statement. From establishing a consistent set of weights and measures, to determining the speed of light, to measurement at the nano level, the ability to accurately measure has been fundamental to the advancement of science and technology.

Standardizing dimensions of products was among the earliest efforts of ASME—with the National Bureau of Standards participating in the development of fire hose threads and other pipe and screw thread standards. These standards may be taken for granted today but they were triggered by a 1904 fire in Baltimore which destroyed more than 1,500 buildings when the fire hose couplings from neighboring areas did not fit the fire hydrants. Standardization of screw threads, fasteners and pipe fittings were also among the earliest standardization activities within the International Organization for Standardization [ISO Technical Committee TC 1, 2 and 5, respectively.] Even today, ASME continues to maintain and update its standards on metrology; the most recent one is on nanometers (instruments for the measurement of surface roughness in the range of a billionth of a meter) here again, is an area in which NIST provided leading edge research.

Throughout the evolution of ASME's standards, scientists from NIST have served as members, bringing to the table the research results of the national institute in order to improve the private sector standardization of advances in technology and to fulfill the common goal of enhancement of public safety and well being.

As another example of public/private partnering, and in the interest of public safety, NIST conducted tests for elevator fire safety which ASME used in its elevator and escalator safety codes. Over the past century, NIST research in advancing knowledge of properties and behavior of materials, atomic physics, cryogenics, optics, electronics etc., and the participation of NIST scientists and researchers on voluntary consensus standards committees, have provided invaluable benefits to the nation's economy and the quality of life of its people. By placing new knowledge into the public domain for application in manufacturing, construction, transportation, aerospace, information technology, and biotechnology, the broadest benefits of federal funded research are realized. And through its incorporation into voluntary consensus standards, commercial realization of new advances by all sized enterprises is made possible.

The participation of individuals from NIST in the standards developing work of private sector organizations has been a vital element in the success of the U.S. private sector standards community.

Cooperative Research

In addition to Codes and Standards, the ASME Center for Research and Technology Development has also enjoyed successful cooperative efforts with NIST.

Some recent examples include:

- During 1994-1995, ASME and NIST (and 3 other organizations) were partners on the Gear Metrology Consortium.
- In 1998, NIST funded the ASME workshop, Changes in Manufacturing Practices for Fasteners.
- In 1999, NIST funded the forum, Innovation in Buildings' Mechanical and Electrical Systems.
- And, this September, NIST will host the meeting of the International Association for the Properties of Water and Steam in Gaithersburg, MD of which ASME is the U.S. member.

The incoming ASME Vice President of Research (a volunteer position) is an engineer at NIST.

Public Policy

Science and technology are no longer the domain of the scientific community—we need a knowledgeable public and a knowledgeable Congress if the U.S. is to maintain its economic growth and world leadership. Recognition of the importance of sufficient investment in science and technology in order to maintain U.S. global competitiveness—and recognition of the importance of supporting the voluntary consensus process—which brings technological advances into the marketplace—can best be accomplished through public private partnering.

The National Technology Transfer and Advancement Act (PL104-113) was a major step in recognizing the value of the voluntary consensus process for standards development and the benefits derived from greater federal use of such standards.

Over the years, ASME has worked with NIST on issues of mutual interest before the U.S. Congress. This includes ASME annual testimony before Congress in support of NIST programs such as the Advanced Technology and Manufacturing Extension Programs.

In the area of international standardization, NIST has been an ally in articulating the issues relating to the need to ensure that U.S. interests are well represented in the international standardization area. As the central inquiry point for standards information in the United States under the WTO Technical Barriers to Trade Agreement, and as a go-to agency for advise on standards-related issues, NIST will have an ever growing impact on the governmental dialogues surrounding standards and international trade.

This partnering of government and private sector in the United States is the envy of industries around the world and it is being emulated by many nations, particularly those in the Pacific Rim. We should all be proud of what we have accomplished.

As a final note, let us here today commemorate the centennial anniversary of our National Institute of Standards and Technology—we all look forward to the strengthening of a 100-year-old relationship.

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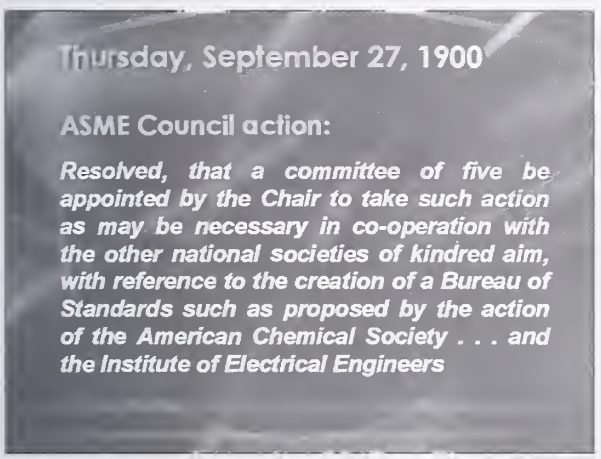

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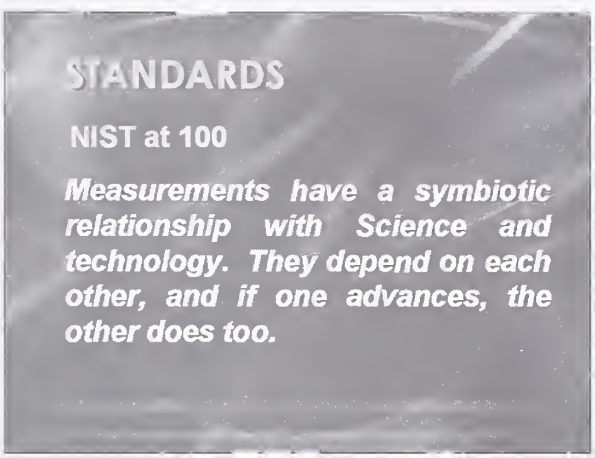

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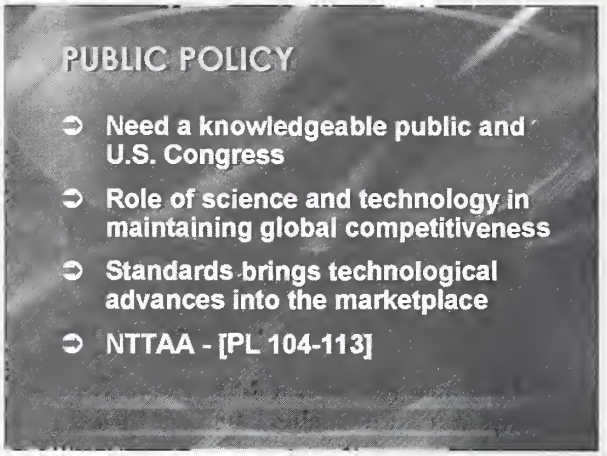

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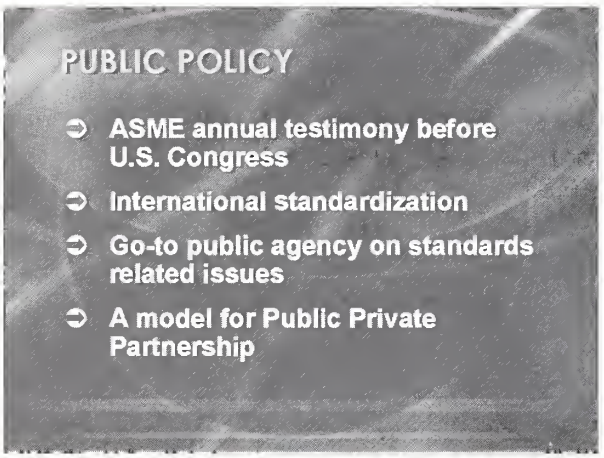

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Standards for Public Benefit

Jim Thomas
President, ASTM

Dr. Brown, Mr. Kammer, Dr. Collins, Distinguished Guests, Ladies and Gentlemen:

We are here today to celebrate a momentous occasion: the centennial anniversary of the National Institute of Standards and Technology. It is a pleasure to be with friends and colleagues who have come today to congratulate this institution and its people, and to say thank you for a long and distinguished service to this Nation.

I have been asked to speak today about the standards partnership that exists between NIST and ASTM and how that partnership has produced standards for the public benefit. Without doubt, these are the facts. But the history we share has much more to teach us than the fact that we could produce standards together. Governments and private citizens produce standards together all over the world. It is, rather, how we did it. The partnership we are celebrating today is a microcosm, a snapshot of this country's history. It is the story of what set us apart from the rest of the world, the story of how a government and its citizens came to share a common purpose and achieve a common goal in an atmosphere of equanimity and balance.

This partnership is a model for governments and private institutions everywhere, a model in which we can take pride, a model that has proven, time and again, what great strides in progress can be made when public institutions and private institutions are willing to abandon traditional roles and old ideas. Our partnership has refuted the idea that public and private institutions are destined to be defined by authority and mutual mistrust.

At the turn of the last century, when ASTM and NIST came onto the American scene, we were a nation on the move. Literally. We were building the great railroads. Steel producers worked night and day to fill the ever-increasing demands of the burgeoning railroad system, making the United States the most prolific steel producer in the world. In the midst of this unprecedented boom, we hit a wall: train derailments by the thousands. Broken rails, broken wheels, and broken flanges and axles began to take a terrible toll on American lives and the American economy. Desperate railroad companies began to import their rails from Great Britain.

In 1898, 70 members of a new association, the American Chapter of the International Association for Testing Materials, met in Philadelphia to discuss the prospects of organizing committees of companies and customers to develop testing methods for iron, steel, and other materials. Three years later, the U.S. Congress chartered the first physical science laboratory of the federal government, the National Bureau of Standards. By 1912, NBS was performing materials research on the iron and steel constituents of the railroad industry, research that advanced and enhanced the specifications that had been developed by the steel companies and the railroad companies in what is now ASTM. American railroads began to be reliable and safe again; and a unique partnership had been forged. Almost a hundred years later, it is stronger than ever.

When we consulted ASTM's membership roster last week, we counted 194 NIST scientists among its ranks. NIST's Annual Report to OMB reported that in the period October 1998 to September 1999, NIST scientists held 572 ASTM units of participation, an astonishing number which far surpassed any like number related to any other private standards developing organization. At a time when there is a general government agency decline in participation in standards activities, it represents the commitment of NIST to our partnership, and to the work of producing standards for public benefit. While this number is important, we can only use it to measure units of activity. There is no method yet devised, however, whereby we can measure the talent and dedication NIST scientists bring to the work of ASTM. To our NIST technical partners therefore, I can only extend my deepest gratitude and thanks.

Dr. Branscomb, if you are in the audience now, I would like to acknowledge your presence. It was during Dr. Branscomb's term as Director, in the seventies, that NBS made some very important decisions, decisions that more clearly articulated the relationship between us, decisions that brought all of us into a more enlightened age. It was during this time that NBS shifted many of its Voluntary Standards Program activities to private sector organizations, opting not to compete, but to supplement private sector programs. It was also during the seventies that NBS decided to become more active in voluntary standardization activities at the policy level, a decision ASTM welcomed wholeheartedly. Soon

service, not only to ASTM, but to our entire community, came at a time when standards development was coming to be recognized by policy makers and industrial leaders as a critical element in the globalization of industry and international trade. We had no national standards strategy to help us cope with our changing world. At an ANSI Board meeting, Ray challenged us to develop one. Ray, your instincts, insights, and guidance have been invaluable to ASTM; and your involvement with the voluntary standards system in this country is very deeply appreciated. Thank you for your help and support.

In 1993, during my first full year as President of ASTM, I had the pleasure of partnering with a NIST scientist named Nancy Trahey. At that time, she was the Chairman of the ASTM Board of Directors, and the second woman in ASTM's history ever to be elected to the Chair. She was an outstanding Chair and remains a great friend. ASTM was the clear beneficiary of her steady, skilful leadership. Thank you, Nancy. Today, as in times past, a NIST scientist still serves on ASTM's Board of Directors, Dr. Leslie Smith. There are other NIST people here and not here, too numerous to mention, who have served on other ASTM policy-making committees. NIST members have brought to our process everything from measurement infrastructures and basic research to—to quote Ray Kammer—"the management of the battlefields for economic competitiveness." Dr. Belinda Collins, whose hard work and dedication I wish also to acknowledge here today, has been a partner who has shouldered some of the heaviest burdens and most difficult challenges of our day, not the least of which was the development of the National Standards Strategy. Thank you, Belinda, for your tireless stewardship.

Time will not permit me to describe the range and depth of our partnership, which goes far beyond the development of standards, but I will mention three outstanding collaborative efforts: (1) Our Cement and Concrete Reference Laboratory partnership, started in 1929, a Research Associate Program in which the manager is a non-government employee and the staff is supported by ASTM; (2) Our Standard Reference Materials partnership, another Research Associate Program begun in 1976 to provide standard reference materials for the nation's metals industry. It now includes glass and fine particle metrology and is managed by our past Chairman of the Board, Nancy Trahey; and (3) Our Grants and Contracts Program that has served to accelerate standards development and the transfer of technology to the marketplace through the resulting standards. These collaborations are all success stories whose implications and effects have been felt worldwide. NIST and ASTM have shared in the outreach to developing countries, co-hosting delegations from around the world. ASTM's Washington Representative, Helen Delaney, became the NIST Standards Attaché to the U.S. Mission to the European Union. ASTM has appeared before Congressional Committees and testified time and again in support of funding for NIST; an act of partnership we will repeat whenever given the opportunity. Together we have supported the implementation of the OMB Circular A-119 and the National Technology Transfer and Advancement Act, instruments that have brought us closer together, instruments that have enhanced and strengthened our partnership.

No other country in the world, even the most democratized, has a standards infrastructure that is built on our concept of a government-private sector partnership. Our system has often made it difficult for us to fit into a world where standards systems are characterized more by legislative or authoritative involvement than by an equal partnership where government is part of the process. However, one has only to look around to see what this partnership for the public benefit has produced: standards that have seen us successfully through two world wars, standards that have restored and sustained our environment, standards that reflect unhampered invention and innovation, standards that make our products household names around the globe, standards of inimitable quality and relevance. Our standards are the measurement of unprecedented prosperity, levels of health and safety, and a quality of life that is unparalleled anywhere. Our standards are the irrefutable result of our way of life, and our partnership.

And so, on this important day, at the dawn of your second century, I bring you ASTM's best wishes. When our railroads needed us, we were there. We set our sights on their survival and success; and the public benefited. Our country benefited. The goal we set out to achieve almost a hundred years ago—to promulgate valid and accurate standards, standards that would promote trade, standards that would increase the quality of life for our citizens, standards that would measure the best of who we are as a nation—is as valid and viable as it was then. May it continue as the basis of our partnership for the next hundred years.

Happy Anniversary.

National Standards Strategy for the United States

National Standards Strategy Panel Discussion
(Edited Transcript)

Introduction by Raymond Kammer, Former Director
National Institute of Standards and Technology

Moderated by Mark Hurwitz, President and CEO
American National Standards Institute

Panelists:

- Oliver Smoot, Chairman
  American National Standards Institute
- Steven Oksala, Vice President, Standards
  Society of Cable Telecommunications Engineers
- James Thomas, President
  American Society for Testing and Materials
- Gregory Saunders, Director, Defense Standardization Program Office
  U.S. Department of Defense
- Mary McKiel, Director, EPA Standards Program
  U.S. Environmental Protection Agency
- Robert Noth, Manager, Engineering Standards
  Deere and Company
- Belinda Collins, Director, Offfice of Standards Services
  National Institute of Standards and Technology

DR. KAYSER: Of course, every partnership involves a two way street, and I think that NIST has been very lucky over the years to have had the best partners that any organization could want.

We will now move on to the next part of the program, which is a panel discussion of the U.S. National Standards Strategy. I am going to start this part of the program by introducing Ray Kammer, who will then introduce the moderator of the panel discussion.

As many of you know, Ray was the Director of NIST from 1997 through December of 2000, and prior to that he held a variety of leadership positions at NIST, and in the Department of Commerce. These ranged from the Deputy Director of NIST, which he held for a total of about 15 years, Deputy Under Secretary for Oceans and Atmospheres in the National Oceanographic and Atmospheric Administration; to Chief Financial Officer, Assistant Secretary for Administration, and Chief Information Officer for the Department of Commerce.

Ray has for a long time been a good friend and ardent supporter of the documentary standards community, and a leader in that community. As Jim Thomas mentioned, Ray served on the Board of Directors of ASTM. He has also served in leadership positions within ANSI. Ray played a key role in the creation of the National Standards Strategy by challenging the standardization community in 1998 to develop such a strategy. It is a great honor and privilege for me to turn the floor over to Ray Kammer.

MR. KAMMER: You are going to hear in a few minutes from the thought leaders who helped develop the National Standards Strategy, and their perspectives on this strategy.

For me, the interesting question is why is the National Standards Strategy developed now. There have been in my career at least three previous attempts to bring the community together and organize it in some way, all of which failed pretty rapidly. This time we have succeeded in getting at least this far.

I have one possible explanation. It is almost speculative, but we all know that product standards create value. Standards do things, such as aggregate markets, and provide a forum for representatives from both supply and demand to have conversations. They compare economies of scale that benefit both the vendors and the buyers. Standards facilitate product compatibility and interoperability, and that has been true for the past hundred plus years.

I think something changed, perhaps 15 years ago, and I wasn't smart enough to notice it. About 15 years ago there began to be cases where a condition of access to particular markets was where and how the standard was developed. This is a trend that has been increasing. Maybe you could call that exclusivity of access, for which I can think of three kinds of existence groups.

There is the *de facto* group, in which I am the head of a company and I won't buy from you unless you manufacture to a particular set of standards. Furthermore, rather than a particular standard, I insist that you manufacture to a body of standards that were developed in a certain way. There is also the *de jure* case, in which there are countries that have recently said we will only participate in certain standards development and in no other. Then there is a special case of the de jure standards, in which a standard starts out like a voluntary product standard, and ends up being converted and adapted in some fashion into a regulation that is administered by the government. These changes have increased the stakes a lot, and my speculation is that that is a significant motivator for why there is a National Standards Strategy now.

Now, I will introduce my friend, Dr. Mark Hurwitz. He was named President and CEO of ANSI by its Board of Directors on July 1, 1999. Before joining ANSI, Mark served as the chief executive officer and the executive vice president of the American Institute of Architects. He is also a past executive vice president of the Building Owners and Managers Association International. Dr. Hurwitz earned a doctorate in administration from Temple University, in Philadelphia.

DR. HURWITZ: Thanks so much, Ray. You are such a great example of what a retired old man looks like. Many of us went this morning to pick Ray up at the rest home to bring him to the event today, and so I hope that you will just treat him well and so on, because he does have to be back by 6:00.

Since he is such a young man to retire, it makes some of the rest of us working, at least this one, a bit jealous at times. But I certainly want to join everyone else in thanking Ray for his incredible leadership and his friendship and his support during his years as Director of NIST, and even before, for his interest in standards. That interest continues today. Certainly this panel is in some ways a tribute to his courage, his challenge, and of course the incredible follow-up of Dr. Belinda Collins, whom you have heard referred to so many times here today.

Since the very diverse 55-member Board of Directors of the American National Standards Institute unanimously adopted the National Standards Strategy last year, it has received wide attention, both domestically and internationally. As a matter of fact, during its development and draft stages it received significant attention internationally as we received feedback to our drafts that we had not deliberately solicited from the international community. We found this to be quite interesting.

Since the adoption of the strategy, about which you are going to hear much more in a few moments, there have been Congressional hearings. I have now even seen some preliminary drafts of a European standards strategy, which is interesting as well.

The National Standards Strategy drives just about everything that ANSI does. Our annual budget for Fiscal 2000 is built and based upon implementation of the National Standards Strategy. Even our staff evaluation system, which is related to the budget and specific goals and so on, is all tied towards focus on implementation for the National Standards Strategy. Each of our four governance councils—the Government Member Council, Organizational Member Council, Consumer Member Council, Company Member Council—are all focusing and working very hard on implementation plans for the National Standards Strategy.

Well, what is the National Standards Strategy? Many people, as I look around this room, have served on task forces that helped to create it. Others have been around it for some time, and have had an opportunity to participate in other meetings where it was discussed. Just to be sure that we are all talking from the same page, we will present a brief overview of the 12 cardinal principles of the National Standards Strategy, so that we have the same base for the rest of our program.

To do this we have chosen a good friend and a hard working guy who was a key player in this task force, where we heard about Jim Thomas and Dr. Collins being involved, along with lots of people in this room, including many of the panel members. The group turned to this guy and said, "Okay, we have worked this long, and now you take everything that we have gotten and put together the next draft." That next draft was pretty close to what ultimately was adopted as the National Standards Strategy. So who is better qualified than Steve Oksala to come up here and spend a few moments with us and provide a framework for us for the National Standards Strategy?

MR. OKSALA: Thanks, Mark. Arati Prabhakar earlier today said something about being amazed that we have created a strategy at all, let alone one that seemed reasonably coherent.

What I want to do in just a couple of minutes before our panel is to set some context as to how we got to where we are, and what the meat is. If there were a defining characteristic of the process of creating the National Standards Strategy, it was the incredible diversity of interests, even among the small group of people who worked on it regularly. I sincerely believe that you could make any statement about the standards process you like, and you would not get unanimity on it, no matter what it was. We all came from different positions, but what we found, though, is that we could agree on a few things.

First of all, we could agree on some basic elements of fair and due process, the kinds of things that have made the voluntary standards system strong for many years. We also found, interestingly enough, that we could agree on some new things, like the need to do it in a very timely way, and the need to have coherence in the process. We also could agree on the fact that one size does not fit all. Each industry sector has different issues, and different problems, and so you can't simply say, well, here is the strategy, cookie cutter, and everybody follow it.

With those agreements, what we were able to do with the National Standards Strategy was develop a framework for all the interested parties to work through and develop some synergy to solve problems moving forward. We did not develop a top down prescription. We did not develop a set of rules that said here is what you are going to do. We did not develop, as the late and unlamented Soviet Union did, five-year plans.

So the strategy is not that kind of thing. What it is, is a set of initiatives, a set of principles which define areas that we believe are important. Each of the organizations in the process should take a look at them, and work out what they can do best.

The meat of the strategy, which you all have in your package so you have no excuse for not reading it, is a series of strategic initiatives covering broad areas. Within these strategic initiatives is a set of tactical initiatives for industry, for government, and for standards developers, which will move the U.S. standards system to a higher level. To finish my little part of this presentation, I will show you what those initiatives are.

First, government use of voluntary consensus standards through public-private partnerships. We have heard a great deal about this today from some organizations who have been doing it for a lot longer than I have been alive, let alone active in the standards world. We understand that this is important. Not all organizations have done it quite as well, so we will need to work this issue further. The need for standards for health, safety, and the environment is a strong tradition in the United States, but one in which we can still do better.

Responsiveness to consumer issues. This issue is one that I think is a relatively recent phenomena for most standardizers. As consumer interests, whether it be ergonomics, or safety, or any of a variety of things, become more important, the representation of consumers becomes even more important in the standards world.

Including the non-traditional standards developers in the process. Twenty years ago this was not a problem, but you have heard today about a variety of consortia and fora, and other organizations. Somehow we collectively—the U.S. standards system—need to figure out a better way of incorporating those activities into an overall program.

Improving processes internationally. Concentrating particularly on ISO and IEC is important because that's where a great deal of the international work of interest to ANSI members is done. Several things can be done. For example, Keith Termaat talked earlier about weighted voting as one possibility. There are many things that we need to look at to make the international standards process as good as it can be. One activity is an outreach program for those outside the United States. Many of you know perfectly well that there are other countries that spend a great deal of money trying to convince other nations, particularly developing nations, to use their standards. The United States has not historically done much of that, and so we recommended a real outreach program to get U.S. standards and U.S. technology better known overseas.

Greater efficiency in the U.S. system. Standards have focused on due process and fairness, and less on efficiency, but greater efficiency is something that industry is demanding these days.

Greater coherence. Since we have a decentralized system with lots of strengths to it, one of the potential problems is that people work across purposes, and so we need to address that.

Improved communications. We need to improve communications between standards developers, and between industry and standards developers, and between the government and industry, among all these parties.

Establish a stable funding mechanism. If you have been in any standards developing organization, you know that money is always a problem, whether it is selling documents, or dues, etc. It is a constant aggravation that takes our attention away from the things that we really want to be doing, which is developing good, solid consensus standards.

And that's my little summary. If you read the document, you will find all of those initiatives and lots of tactical initiatives to go with them. And with that I will return to the hot seat.

DR. HURWITZ: We have turned up the lights because we have all been sitting here all day, listening to wonderful presentations. There were numerous times that I wanted to ask some questions, but of course time did not allow that. We are trying to get an awful lot done in one day. But this session is for you, the audience. We have assembled a panel for you whose biographies are all within your packets. I wish I could remember the exact quote from the Lake Woebegone Radio Series, but everyone up here is beautiful, handsome, and above average. They are all eminently qualified, and representative, as well.

On this panel, we have Oliver Smoot, Chairman of the Board of ANSI, who brings a perspective from a trade association in the standards business as well. You have just heard from Steve Oksala, who is now with a trade association, but was with UNISYS and brings an interesting perspective. Jim Thomas, our friend from ASTM, a standards developing organization (SDO). Greg Saunders, from the Department of Defense, brings a government perspective, from what was at one time the largest standards developer in the world, and whose use of standards is just phenomenal. Mary McKiel is from EPA, and of course you know their significant involvement in standards as well, and brings another government perspective. Bob Noth, from Deere and Company, is a very, very significant player in a very important sector, both domestically and internationally and brings an industry perspective. Finally, our friend, Dr. Belinda Collins. I can't say her name without saying our friend, but it's true. Dr. Collins brings a NIST perspective, as well as another government perspective.

We would like for you in the audience to identify yourself, and tell us to whom you are addressing your question. Just to get started, I will ask the first question, and give you some time to collect your thoughts. Let me start with Bob Noth. Bob, if I might, what has been the reaction of industry to the National Standards Strategy?

MR. NOTH: Obviously I can't speak for all of industry because I don't represent all of industry, of course, while I am up here. But of those that I know and interact with from various industry sectors, I would say that their reactions have been positive for the most part, and neutral in the worst case scenario at this point. In fact, I have only heard one negative at all, and that was from a trade association representative. I think their position was that they were working very effectively in both the national and international standards community, and didn't want anything in terms of a national standards industry hurting them. I think in general that there is nothing in the strategy itself that does any harm to anybody's current tactics relative to international standardization.

The one thing that is probably a problem with the strategy is that the people that I have talked to, and the people that actually know about the strategy, are probably a relatively small number compared to the whole of U.S. industry. That suggests obviously that we need to continue to aggressively market the strategy to all of industry, small and medium size, as well as large. It needs to be given top billing on the agendas of the major players in the standards community, to call attention to it. We need more sessions like this to explain what it is about and how it can be used effectively to improve the U.S. approach to standardization.

DR. HURWITZ: Good. Thank you very much. Has that stimulated you in the audience enough yet? Yes?

MR. MESERLIAN: The question is the problem that I am having is that our standards are very specific. The gentleman from Motorola said that the key to the National Standards Strategy is having all members of the ICSP be responsible for utilizing any private sector standards development organizations, health and safety standards, and to basically champion them.

In ours we have specific cases where we have requirements for NIST, the FDA, CDC, and the Consumer Products Safety Commission, to take action. I am having a big problem trying to get the CPSC to take action on this. Will NIST be able to recommend that the CPSC representatives do their job, and have these standards considered in a regulatory agency?

DR. HURWITZ: Dr. Collins, since you Chair the Interagency Committee on Standards Policy (ICSP), perhaps you would be the best person to respond?

DR. COLLINS: Thank you very much, and thank you, Mr. Meserlian, for your question. As you know, the Interagency Committee on Standards Policy is a coordinating committee of the Federal Government, which reports on the use of standards by Federal Agencies, participation in the process, and use of any agency unique standard. We have in fact circulated information on your standards to all ICSP members, and advised them of your role in developing standards. We have also circulated information on other standards developing organizations. There are some 600 in the United States, so it makes it difficult to give preference to one standards developer over another. I do know that CPSC is aware of your standards and is examining them in the course of their regulatory process. A key role of the ICSP is providing and sharing information on what is happening in the voluntary standards arena. What we have done to circulate information about standards in general, and specific standards procedures in particular.

DR. HURWITZ: Thank you. And I apologize to the panel, because I didn't hear the beginning of that. Let me just again repeat that I am looking for questions regarding the National Standards Strategy, its content, and how it was developed, and how it is being implemented. If you have questions about individual organizations, and you want to talk to some people on the panel, I think that ought to take place after this session off-line. I apologize, Dr. Collins, for not more carefully screening the question.

Well, Dr. Collins, I will keep you up there though. What are the ICSP and the Federal Government doing to implement the National Standards Strategy, and what are NIST's plans in that regard?

DR. COLLINS: The ICSP is responsible for coordinating standards-related activities across agencies. As the standards strategy notes, a key issue is that the Federal Government use voluntary consensus standards.

We have heard a lot of discussion today about NIST's role in that. I want to emphasize that the only reason you heard so much about NIST today is because it is our 100th anniversary. On this panel, we have representatives of two other Federal agencies—DoD and EPA—and we also have at least NASA and the FDA in the audience. All of these agencies are strong users of voluntary standards, and strong participants in the process.

All Federal agencies are committed by law to use voluntary standards to the extent practicable. We are now seeing a marked increase in the number of such standards used by Federal agencies, with an accompanying decrease in the number of agency-unique standards developed. The ICSP is continuing to emphasize Federal use of voluntary standards, while working on new tools for reporting on activities, such as the web-based reporting system that NIST implemented this year.

NIST and the ICSP plan to take a look at the idea of possible Federal use in some fashion of the ANSI accreditation process. We also plan to expand our activities to ensure that Federal agencies are aware of relevant voluntary standards activities, relevant training, and work in partnership with ANSI and other SDOs to know what standards are being developed, and how those meet agency needs. We continue to be aware that agency needs reflect those of the private sector communities that we serve.

As we think about the global market, I will also point out, that NIST plans to continue its outreach program. As I said at the beginning of today's session, we have 20 representatives from Russia and the Newly Independent States in attendance. They are here as part of a 2-week training course at NIST on the U.S. voluntary standards community and system. They will then spend time in the private sector looking at telecommunications, in this particular case, but we have done a number of such workshops looking at different sectors. For example, we have one coming up in a couple of weeks targeted at electrical safety in the Asia Pacific region.

NIST intends to continue doing this sort of outreach, but I want to stress that it happens in partnership with all of the people up here on this stage and in the audience. NIST serves to facilitate, and I think that is our key role within the ICSP.

DR. LYONS: I am asking this question to ANSI officials. My question is with regard to performance based standards. In recent years the Department of Defense has made a really extreme effort to convert their acquisition specifications to performance based specifications. That involves, of course, adopting largely private sector standards. In the course of doing this, I have had the opportunity to listen to CEOs from business react to this, and in general one finds that large companies think this is wonderful. If you listen to CEOs from very small businesses who are used to manufacturing against a very detailed prescriptive specification, such as small truck manufacturers for the Army, for example, you hear a very different story. This is very upsetting to them. Their statement is we don't have a design staff, and we don't have the capability to make a proposal against a performance based acquisition specification. The response that the Generals give them is, you know, somewhat indefinite. But, it seems to be a real problem, and my question to the ANSI folks is what feedback do you get from small businesses to the performance based emphasis?

DR. HURWITZ: I would ask Mr. Smoot, Chairman of the Board to pick up your question. Other ANSI board members may also want to help out as well.

MR. SMOOT: Well, Mark may have chosen me by my title, but I come from an industry where there are a large number of companies that range from one and two person shops, all the way up to mega-firms. Those firms that do business with the Federal Government would fail the small business definition by the time that they get into government business support for IT products. If the products are custom built, it is not a problem in software. It is not actually a problem for IT products for specialized hardware. So I think we would have to ask somebody who deals with machined metal, or other hardware, where you need an infrastructure or plant where you build things.

DR. HURWITZ: I wonder if Bob Noth has some insights here.

MR. NOTH: Thanks, Mark. I could see that coming. I think you make a very good point. I am not much into government contracting, and so I really can't answer the specific question. I will point out, though, that one of the things that we are doing in our industry is to use performance based specifications. We fully believe in performance based specifications, as opposed to prescriptive ones, because performance based gives us the flexibility to be innovative and creative in how we meet those specifications.

Prescriptive specifications tend to cool innovation. Where we have done innovations, and have asked our supplier community to help us, we still are fairly prescriptive in our specifications of what parts we want made. Alternatively, we partner with the supplier and let them participate in the innovation process with us, so that we supplement any lack of engineering staff that they have.

I assume other industries are doing the same. What little bit I know, and maybe Greg might have a comment on that, would be that many of the defense contractors that I was aware of were fairly large firms, or consortia of firms, who then would probably have the capabilities to do the necessary engineering, and then they would use subcontractors to provide parts in the same kind of way.

DR. HURWITZ: Greg, can you help us with this question? I mean, DOD has about a hundred billion dollars per year in procurement or more.

MR. SAUNDERS: Yes. Let me say a couple of things. I once testified before Congress and started out my testimony about performance specifications by trying to describe a number two wooden pencil in performance terms. It is an extraordinarily difficult thing to do, and when you are finished, pencil manufacturers don't recognize it.

Let me say that the Department of Defense has not thrown away all detailed specifications. Where we are moving to performance specifications is largely in larger things. We want to buy aircraft based on the required performance. When we are buying spare parts, we still have literally thousands of design specifications. We do deal with firms that range all the way from Boeing-sized to single person contractors, and we do recognize the issue of not having design staffs.

Although in some measure—and this sounds a little cold, but in some measure—that is not really our problem. What we want to do is describe the performance that we need and allow industry the greatest flexibility to meet those needs. If they decide to meet those needs using old military specifications and standards, that is just fine. They can continue to use those documents. There are still a good many of them out there, and many of the those that have been either cancelled or turned over to a voluntary standards organization contain a great deal of detailed design information that is still usable. DOD still buys products built according to these detailed specifications.

Let me relate this back a little bit to the National Standards Strategy. One of the goals in the National Standards Strategy does say that we want to give preference to performance specifications. But, in virtually every case, for every specification, and every standard, there is some balance between giving detailed design requirements, detailed process requirements, and performance requirements. What we want to do is swing a little more towards the performance side, and a little less toward hemming in our contractors with a detailed design, or a designed process, that would prevent them from being innovative and giving us the best that they know how to give us.

DR. HURWITZ: Thank you. Sir, identify yourself and your question, please.

DR. BRANSCOMB: Lewis Branscomb, on my fifth retirement. Jack Goldman used to say that if the manufacturers of buggy whips at the turn of the century had understood that their job was to fulfill a performance requirement as a vehicle accelerator, they would still be in business.

My question derives from the fact that 30 years ago I broke my pick on a massive study for the Congress on how to get this country metric. The only thing I have to show for it is a death threat from a citizen who was for the metric system, but thought we should have a hundred degrees in the circle instead of 360. And my question is pretty obvious, and that is if we have a National Standards Strategy, where is the accelerated metric conversion in it?

MR. OKSALA: I have to confess that I don't recall that subject coming up at all during any of our meetings, and I think that was probably an individual decision about discretion being the better part of valor.

DR. HURWITZ: I think Director Kammer might have some insights there.

MR. KAMMER: As Dr. Lew Branscomb, I suspect, already knows, there are no examples in the world of countries converting to metric without it first having been made mandatory through some legislative process or some directive from the government. Time and time again, we as leadership of the country have walked up to this issue and said, no, I don't think the American public wants us to order them to do it.

The irony of this is that your automobile is completely metric, unless it is very, very old, except the tires, odometer, and speedometer. So, English unit wrenches, of which I have a handsome and complete set, don't fit anything that I own anymore. So a lot of the industrial world has converted, but the interface with the consumer has not, and I predict won't unless there is a legislative instruction.

DR. HURWITZ: Okay. Steve, and then Ollie.

MR. OKSALA: I think that is a perfect example of something that I mentioned earlier in regard to the strategy. I think we all agreed that you simply couldn't standardize at the top level. That is, that each industry had to go about finding its own way through these issues, and one of the consequences of that is that you don't necessarily hear about it. In fact Keith Termaat and I were talking earlier today, and he made the simple comment that the metric battle is over for the automotive industry, and the reason is that the industry decided that it was in its best interests.

Now, there are other industries. I believe the aerospace industry has a different view about the issue. But that's where it gets solved, at the specific industry level. So you won't find a National Standards Strategy that says "thou shalt" do much of anything actually, because it is really important to do it within industry sectors where the solutions fit that industry.

DR. HURWITZ: Great. Ollie, did you have something to add to that?

MR. SMOOT: I just wanted to remind everybody that I think it is now 9-1/2 years and ticking until the European Union will say that the final extension has run out, and we are going to go to single, hard metric labeling in the European Union, which presumably by then will be some number of countries larger. I will repeat what Steve said. A lot of industry has made this conversion, unless they have very good reasons why not. Aerospace is a good case study in why one might not want to take that risk. It really is the American public that is living in a bubble. But if you can't change their mind, I think that industry that has to compete both locally and globally will all go metric and just won't tell the American public.

DR. HURWITZ: Yes, sir, a question?

MR. RIPPEY: Bill Rippey, from NIST. When I promote standards, one of the arguments that I make to the users of technology is that if we have a good interface standard for the components in your system, you will have more choices of component vendors. As a result, when you buy a brand new system, you will be able to mix and match. If you have an old system, and one component wears out, you won't have to go back to the original company, but you can shop around for a different company. First, is that a good argument for standards? Two, do you think that is upsetting to vendors of technology? If there is a problem with vendors accepting this argument, how can we make it more palatable to vendors of technology?

DR. HURWITZ: If there anyone in specific that you would like to have respond to that question? Okay. Bob.

MR. NOTH: It is a good argument if you are in the supply industry, and it is a good argument if you are a consumer. But the large OEMs probably object to it, in the sense that they are trying to differentiate themselves, and they probably have an after market parts business that they are trying to keep focus in. So that doesn't mean that OEMs don't still support standardization. It just means that you will find some negative reactions in the OEMs. In the supply industry the reaction can be mixed, too, though because many of the suppliers want to differentiate themselves. I will use the electrical connector industry as an example. There is no interchangeability in electrical connectors, only from brand to brand to brand. They are all proprietary within their own lines, but they are not interchangeable, and so from an industry perspective, those suppliers aren't going to buy into standardization because they are trying to differentiate their product line uniquely.

MR. OKSALA: Yes, just to add to that. One of the things that I found to be a very effective test for the success of standardization is considering it to be an exercise in the elimination of low value product differentiation. If the product differentiation value is high in the perspective of the vendor, then they are not going to be very amenable to standardization. If it is low, or if they are being outnumbered 800 to 1, then they will. So it becomes a competitive issue. If you are lucky enough to have a monopoly or quasi-monopoly on a design, then you are not going to pay much attention to standards, and you probably will be successful.

I actually think the answer to the question is slightly different. I don't think any vendors will get upset at you for referencing standards. They just may not agree with you, they may not be responsive to you, and if you can't find other vendors, then I guess they are right.

DR. HURWITZ: Thank you very much. Yes, sir?

MR. FRENCH: Jim French, with the American Institute of Aeronautics and Astronautics, and I am also a member of the ANSI Executive Standards Council. Now, within ANSI, we talk a great deal about—and in fact we promote—accreditation. Yet, in the strategy we are advocating reaching out to consortia. Now, many of the consortia couldn't qualify for ANSI accreditation. So how do we work together this seeming contradiction?

DR. HURWITZ: Thank you. We hoped for that question. Ollie?

MR. SMOOT: I sure wish I had had two hours this morning for my talk, because there were a lot of things that could be said, and this is one of them that got very little attention.

ANSI represents the U.S. societal interests in standardization and conformity assessment. It doesn't represent the ANSI accredited standards industry. So in my view we have actually been laggard in reaching out, because we already have as ANSI members some very large developers of standards documents that don't process their documents through ANSI's approval process. We also have some large developers of specifications who are not accredited, but they see an interest in being an ANSI member. While they are consortia using different methods, many of them face some of the same policy issues, especially if they would like their documents be accepted globally as accredited standards developers do. After all, they serve the same user base as accredited standards developers do. They simply provide a different service. So to that extent, I think there ought to be an identity of interest that would cause them to want to be ANSI members. What we—as ANSI—need to do, is to pull ourselves together, and figure out our value statement, and actually reach out to these organizations that do want to work with the rest of the ANSI members in improving the overall system, both domestically and internationally.

MR. THOMAS: I would just like to follow up. I think the question can be taken two ways. Is there an objection to having consortia being members of ANSI? I would think that absolutely there should be no reason not to want to cast a net, and have all of those that are involved in issues pertaining to standards, and the application of standards for trade to be part of ANSI.

Then there is another question as to whether some of the basic fundamental principles that have driven the U.S. consensus standardization process related to openness, balance of interests, representation from all the affected interests, and all those conditions, have become essential elements of the U.S. consensus process. The follow-up question is whether or not ANSI would change its accreditation criteria to essentially create some kind of a system for accrediting organizations that may not fulfill all those fundamental principles, approve them, and offer them recognition for the development of an American National Standard. ANSI currently does this through its accreditation process. There are actually a couple of different issues all wrapped into that one question. It really is a matter of the degree of comfort you will have if you move in a direction whereby groups of like-minded companies, essentially not with all the balance of interests, are accredited to develop American National Standards. Is that the direction that ANSI wishes to go?

I think there are some issues that will have to be resolved within ANSI as it determines what role consortia will play, and decides exactly what part of the ANSI process, or the ANSI policy framework that the consortia will fit into.

MR. OKSALA: One of the reasons that this comes up as a strategic area where we felt that we needed to say something, is that in what I will characterize as the hi-tech industry, and certainly the computer business, what we have noticed is a rapid increase in the number of consortia, and a decline in the participation in formal standards bodies. I know a number of companies that have said that they were spending just as much money on consortia, as they ever did on standards. I think the same is true in the qualifications industry as well.

To the question of whether we in the formal standards process are failing to provide what our customers want, then we at least need to look at that. Now, I am familiar with a number of consortia, and know that there are some that are not accredited by ANSI, precisely because they don't want to follow the kinds of due process and fairness rules that ANSI accreditation brings.

There are others who say, well, we are international, and so why would we want to be accredited by an American organization. There are still others who just don't know how the U.S. standards system works. There is no simple answer, but the point of the strategic initiative for ANSI is to look at this issue to understand why organizations are going in this alternative route. Then we can determine what if anything that we in the standards system can do to have a more coherent process.

MR. NOTH: Mark, just one little addition to that. I don't think that all technical specifications, and everything else, need the same level of public review as those that might affect health, safety, and the environment. I think we heard similar ideas from a couple of speakers this morning that not all standards may need to be considered as international standards for particular areas or applications. It appears that there might be room for different developmental processes and levels of consensus if we can figure out how to break down the word "standard" into various classifications. If we could apply a different process to those classifications, it might make some sense. We have not been able to effectively do that as yet, but I think we ought to consider trying it. We tend to lump all standards into one category and one process so one of the reasons we put consideration of consortia type standards into the strategy was to force us to consider different possibilities.

MR. SMOOT: Bob said very much what I wanted to say, except that I wanted to point out that we have a great deal of input from regulatory agencies in the development of the strategy that basically said that we have the OMB A-119 Circular (and the National Technology Transfer and Advancement Act) that give us some guidelines. In addition to fulfilling our statutory mandate, we have to demonstrate certain things. We have to show that we meet the statutory requirements, and frankly documents that come from too "loosey-goosey" an organization aren't going to—they are going to get challenged. So the pressure from them was actually on ANSI to consider maybe tightening up the accreditation process. I would like to hear Mary McKiel from EPA address this topic, since she comes from a regulatory agency.

DR. HURWITZ: I do have a few questions about consortia that I do want to ask, but first I will ask Dr. McKiel to address us. From a standards perspective, what is the difference between the National Standards Strategy and the National Technology Transfer and Advancement Act of 1995 (NTTAA) which requires Federal agencies to use voluntary consensus standards? Does having both really mean anything?

DR. MCKIEL: I would characterize it this way. The NTTAA directs agencies to do two things. It directs agencies to use voluntary standards when it is consistent with the mission of the agency and its budget, and if it is practicable. The second thing that it directs us to do is to participate in the development of those standards. The OMB A-119 Circular elaborates the direction given in the law and gives us guidance. It also explains what we have to report to Congress every year through NIST and OMB on how well we are doing to implement the law.

OMB and Congress are at this point particularly interested in knowing if there is an existing voluntary standard, and if it is applicable to a regulatory action, that you explain why you didn't use it. Now, there were other things that we were asked to report, such as how many people do we have involved and a couple of other things. Congress has made it clear that a big highlight for them is that an agency had better be able to explain to the public why they did not choose to use an existing standard in their regulatory and procurement actions.

This gets to one of the points which the gentleman who is sitting at the microphone brought up a little earlier, that the law and the circular give the individual agency the authority not just the responsibility, but the authority— to make the determination of whether or not a standard is applicable. It also gives the authority to the individual agency to determine the process for making this determination. That's really key for understanding, because the NTTAA and the OMB circular are directed inward to tell government agencies what to do, how to relate on an agency basis to standards developing organizations, and through the ICSP, how to coordinate with one another.

The National Standards Strategy is really directed towards the whole federation. It is all of us. It is not just for the government. From a government perspective it gives us a road map of how to implement that part of the OMB circular that tells us to communicate with the SDOs. Furthermore, the strategy can help us in our relationship, not only with one another, but also in putting together issues that may not be individually realized within a particular agency, but which are important to the U.S. Thus, each agency has the ability to get with other agencies and the private sector academia, consumers, organizations, and sit down and say that, as a whole, here is what the picture looks like.

I don't have a big part in this, but I understand where you are coming from. So down the road, it may be important. I think that what our Chairman, Ollie Smoot, brought up is also really important. The National Standards Strategy is a great and wonderful thing.

In terms of who knows about it, we have got a lot of work to do. I can tell you from a regulatory agency point of view. I am the EPA Standards Executive so, of course, I know about it. My job is to make sure that the other 20,000 people in EPA also know about it. One of the issues there that is important to the regulated community is that EPA delegates a lot of its authority on regulations to the States. This gets to another part of the strategy. If we really want the strategy to work so that we have got people understanding not only reading off the same page, but also knowing that there is a page, we really have to get the States involved. This is particularly true for those of us who are in the regulatory agencies. But it is a two-way thing. We have to provide communication and outreach based on our regulatory relationships with the States, and industry also has to provide education and outreach to State regulators. They may not seem like they are your best friends all the time, but the only way we are going to get this strategy really on target down the road is to work together to try and make the community larger.

DR. HURWITZ: Thank you very much. I am being yanked and pulled, and lights blinking at me saying it is time to sum up, because I understand that we started a few moments early. So therefore, I apologize, sir, and perhaps you can submit your question in some other form. To sum up, there were a lot of great questions asked and great answers, of course. Some other issues that I had hoped to be brought up were that the greatest challenge we have is with implementation.

The answer from my perspective would be for everyone to become knowledgeable and committed, and try to report back to us on a regular basis. We will be putting a network in place for that, to report the actions that are being taken by industry, SDOs, government, and consumer organizations, to move forward and implement the National Standards Strategy.

On behalf of the audience, I want to thank this panel that was assembled here today. You have got a lot of horsepower up here. I think we could have sustained a lot longer dialogue, and a barrage of even more controversial questions. I had some great ones to ask all of you, but I am getting yanked over here by Belinda's well-trained team. Since they are directly linked with an embodied chip to the atomic clock, then I am up against difficult odds.

So I want to thank the panel on behalf of the audience. Would you please join me in thanking your panel?

(Applause.)

DR. HURWITZ: And, the panel, would you join me in thanking the audience for listening and participating.

(Applause.)

DR. HURWITZ: Thank you. And with that, I think I turn it back over to Rich.

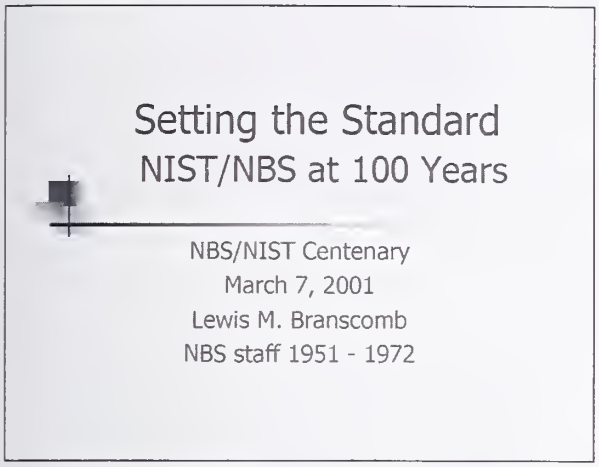
DR. KAYSER: We really are in the home stretch now. Last, but not least, we are going to have one more presentation on history and perspectives. Dr. Lewis Branscomb will give that presentation. Dr. Branscomb is the Aetna Professor of Public Policy and Corporate Management Emeritus at the John F. Kennedy School of Government, at Harvard, and the Director Emeritus of the School of Science Technology and Public Policy Program in the Belfer Center for Science and International Affairs.

Dr. Branscomb was the Director of the National Bureau of Standards, now NIST of course, from 1969 to 1972, and he was Vice President and Chief Scientist of the IBM Corporation from 1972 to 1986, when he joined the faculty at Harvard. He has received a very long list of honors and awards, and he has written extensively on a wide variety of topics, many of them having to do with science and technology, and innovation. It is my pleasure to introduce Dr. Branscomb.

History & Perspectives

Setting the Standard: NIST/NBS at 100 Years

Lewis M. Branscomb
Prof. Emeritus, Harvard University
Former Director, National Bureau of Standards (NBS), 1969-1972



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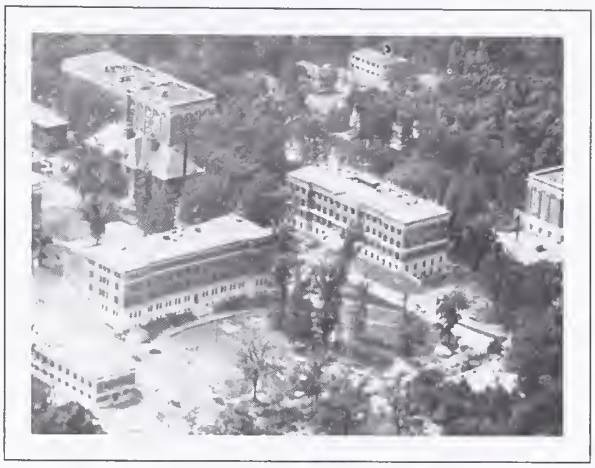


SLIDE 2

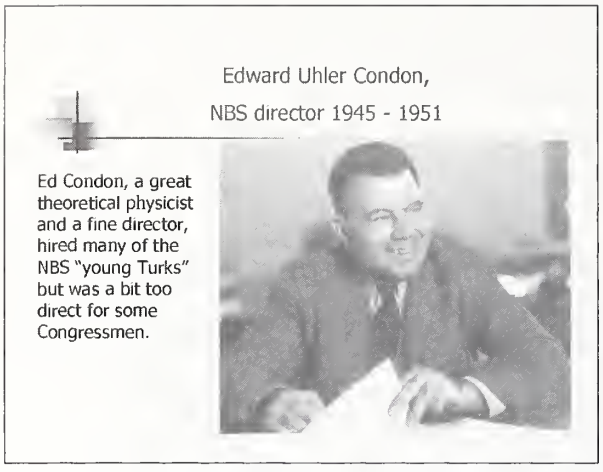
I joined the NBS staff just 50 years ago. 1951 was an exciting time at NBS, as 2001 is at NIST. NBS was emerging from 20 years of depression and war. Ed Condon was director; he recruited quite a number of young scientists after the war Ernie Ambler, Steve Smith, Karl Kessler, Charlie Herzfeld, Herb Broida, Pete Bender, John Hall, Larry Kushner, Jack Hoffman, and lots of others. It was good time to be a scientist. People at cocktail parties acted impressed when you were introduced as a physicist. We young scientists were cocky and irreverent; I guess some of us still are. We looked to a future both threatened by nuclear weapons and bright with the promise of expanding national investments in science and technology. But we had no doubts about what we could accomplish in science and what science could do for the world.

Still, it is hard to realize how different things were in 1951. When you went out Connecticut Avenue to Van Ness Street you felt like you were going out into the countryside. If you were attending the spring meeting of the American Physical Society, all of you met in room 250 of the NBS East Building. [Slide 2] The National Science Foundation was only one year old. ONR was creating a new relationship between science and the military, which would set a precedent for other agencies later.

Compared to today, science was in an incredibly primitive state at that time. Biology was largely descriptive. Chemistry was heavily empirical and rested primarily on valence theory and symmetry properties. The Quantum Theory was still young, and only two body mechanics could be solved exactly. Engineers prided themselves on being able to do things science could not explain, based on their experience and tacit knowledge. In those days science required a National Bureau of Standards to press forward with new instruments, accurate measures of the property of matter and materials, and all of the methods of precise and accurate measurement. It was no accident that NBS focused on its reputation in basic science, and men like Edward U. Condon, one of the leading theoretical physicists of his day, were appointed Director.[1] [Slide 3]

1951 was also the year Ed Condon left the Bureau's directorship for the Corning Glass Works. Ed, who was born in Alamogordo, NM, had tried to educate the congress about nuclear weapons and fought for civilian control. In return Congressman J. Parnell Thomas, who wrote in a House Un-American Activities Committee report, attacked him, "It appears that Dr. Condon is one of the weakest links in our atomic security." Ed stayed on as Director long enough to see Congressman Thomas thrown in federal prison. [Slide 4]

[1] Edward Uhler Condon was director of NBS from 1945 to 1951.



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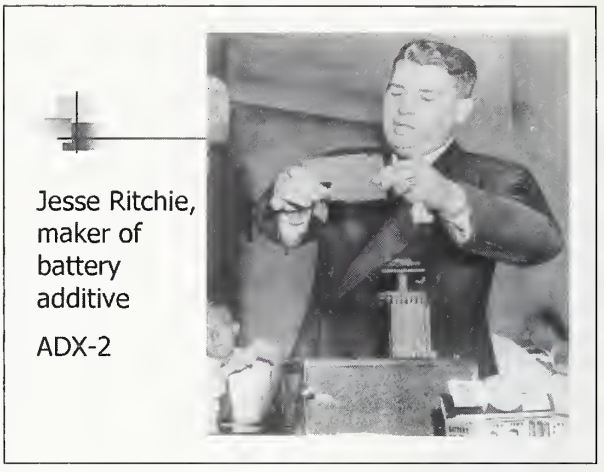

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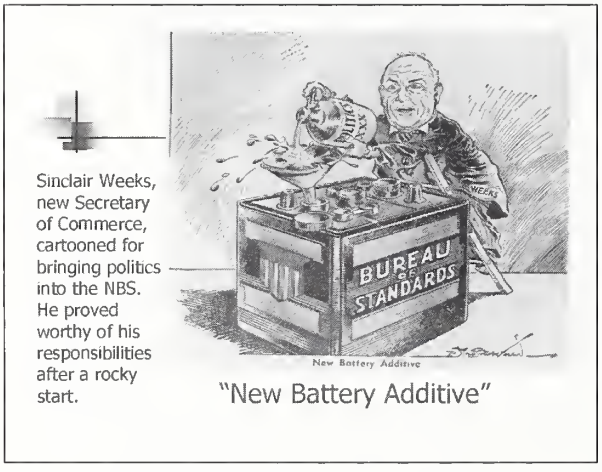

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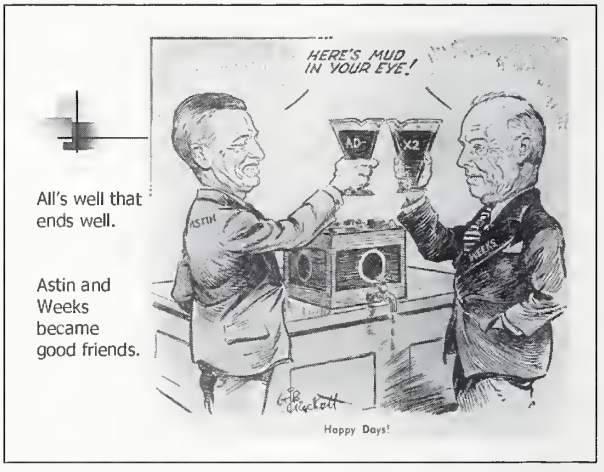


SLIDE 6

But quite apart from the political abuse he received, he left just in time to avoid the gravest challenge to the Bureau's scientific integrity the firing of his successor, NBS director Alan Astin over battery additive ADX-2.[2]

I am sure you all know the story of this challenge to the Bureau's electrochemistry work by an ambitious entrepreneur named Jesse Ritchie. [Slide 5] I discussed that story on Monday; let me here only reiterate that had the Bureau not stuck to its guns, had the scientific community especially the Statutory Visiting Committee and the National Academy of Sciences not come to its aid, and had Secretary of Commerce Sinclair Weeks not been a man of extraordinary integrity himself, willing to admit and correct a mistake, the fine NIST laboratory we see today, here and Boulder, would not exist. [Slide 6]

In the 1950s, the Bureau's responsibility for providing the underpinnings for progress in science loomed large in its vision, in no small part due to Marvin Kelly's advice to Secretary Weeks following the ADX-2 debacle. For science to mature as a source of new technology and of understanding how to use that technology, its quantitative base had to be secure. This is a huge task. Very few scientists in academic settings make absolute measurements. Everyone assumes that their work can be related to the real world by reference to measurements traceable to NIST. [Slide 7] I is my contention that the incredible progress of science and of engineering and medicine in the last 50 years, made possible by the work of NBS/NIST and its sister laboratories abroad, has transformed the nature of

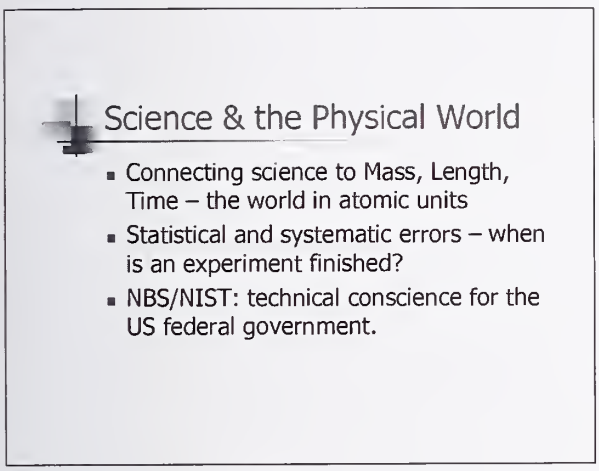
[2] Technically, Weeks did not "fire" Astin, who served at the pleasure of the President; he asked for his written resignation. Presumably he did not send the resignation to the White House, since if it had been accepted President Nixon would have had to reappoint Astin and the Senate would have had to reconfirm him.

science and engineering and has altered profoundly the environment within which NIST must set it priorities.

Today the U.S. innovation rate far exceeds anything society has experienced in the past. This is made possible by the richness of the stock of scientific knowledge and the power of the tools of technology to dip into that stock and create new materials, new processes, new ways of solving problems to fit the needs of the moment. [Slide 8] *The limitations on solving problems are no longer mainly technical; they are socio-economic and even cultural, institutional, and political.* This trend places even more serious demands on institutions like NIST and puts the world of standards making in a new light. It is my contention that we are just beginning to fully understand the processes by which science creates economic opportunities and these opportunities are realized in a socially constructive manner.

Today's discussion has been about standards. For most people this brings up thoughts of finding a metric wrench with which to tighten a metric screw, or setting the rules for inspecting beef. For most people standards is a MEGO subject if there ever was one.[3] But of course this audience understands that engineering standards are the language of commerce, that the whole industrial system would collapse if every time a firm sent out a purchase order for screws it had to spend 6 months studying the design and metallurgy of screws and then write a 100 page engineering test specification for the parts it wanted to put out for bid.

[Slide 9] *Standards are ultimately about the ability to specify, accurately and quantitatively, the function, performance, and reliability of a physical object or a technical system.* This capability is what enables and sustains the progress of science, of technology, of invention and of innovation, and ultimately of citizen satisfaction. This ability to characterize an object or a system in quantitative terms—with known accuracy — in traceable units of measurement—is not only essential to buying nuts and bolts. It is essential to traversing the so-called Valley of Death to reach the goal of a new product innovation. [Slide 10] NIST is engaged in a way unique to our government with every step in that national system of innovation.



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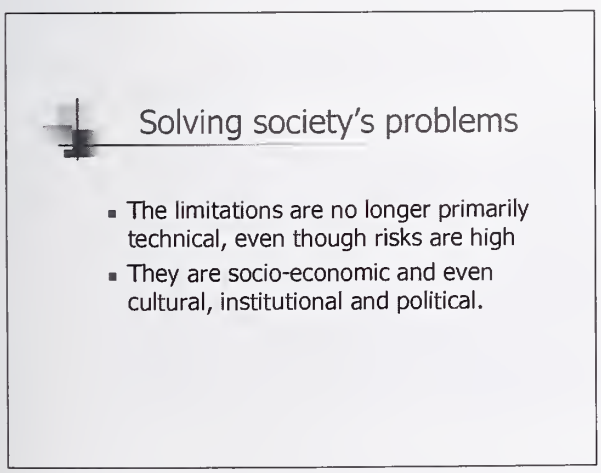

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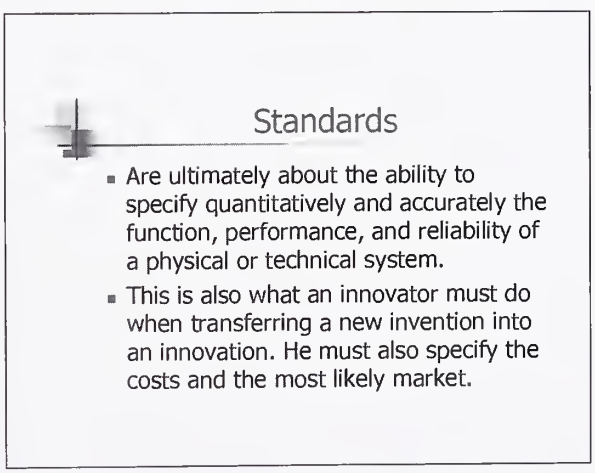
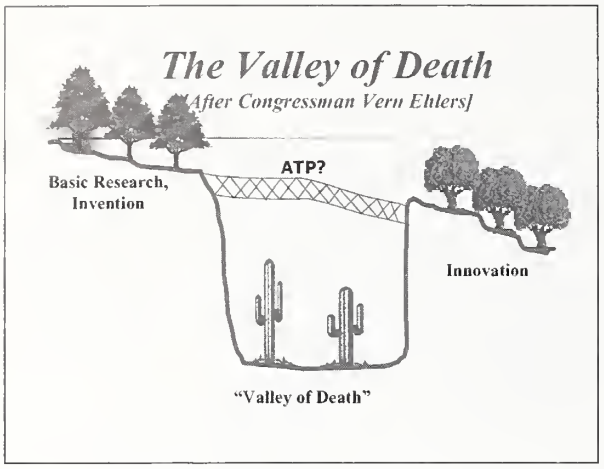


SLIDE 9

[3] MEGO = "My Eyes Glaze Over"



SLIDE 10

I want to persuade you, in the few minutes that remain to us in this great celebration, of four things:

1) Market forces alone will not sustain the fruitful and efficient transformation of high tech inventions to innovations; there is a critical role for government in basic technological research required, performed collaboratively with firms and with universities, to facilitate that transformation. The NIST Advanced Technology Program, ATP, is the only serious effort in the U.S. Government to understand this need and find the right government role in addressing it. It should be improved and expanded, not killed as its conservative critics call for.

2) For society to make wise technological choices through democratic processes, the legitimacy of the technical experts and the integrity of their institutions must be established and sustained. NIST is not just another agency, another government laboratory. It must be, and is, a uniquely trusted partner in addressing technical issues vital to the public interest.

3) Once that legitimacy is established institutions like NIST must create the institutional environment in which the connections between technical activities and the interests of citizens and government officials can be based on trust. NIST does not throw its technical knowledge over the transom, so to speak; it must help create the receptive processes and institutions that can use that knowledge in the public interest. This is what all the standards committee participation, all the ATP and MEP projects do.

4) Science not only creates technological opportunities; it informs us on how to make the right technological choices. This requires a consciousness of social issues and humane values that must inform the collective judgments of society, made through democratic processes. NIST cannot carry out this very important and challenging mission without a broadly based and powerful capacity in basic scientific and technological research and research on the processes of the innovation transformation.

Let address these four issues in turn.

The US Government must implement the responsibility it undertook in the 1988 Trade and Competitiveness Act to ensure that the system of discovery, invention, and innovation in our society is healthy. This requires an extraordinarily sophisticated matching of public investments in science and research to private investments in entrepreneurship and economic growth. [Slide 11] The conventional model is of two separate systems one the science research system, with its laboratories, graduate schools, and its public support—the other the system of businesses, with their own management schools and systems of capital aggregation and finance. These two systems are very poorly connected. Yet the flow of value from $90 billion in public funded research to a trillion dollar manufacturing economy depends on that linkage. Congressman Vern Ehlers' Valley of Death diagram illustrates the nature of this gap and emphasizes the risks entailed in its transit. But a desert is a poor metaphor for this gap, except in emphasizing those risks. I prefer a metaphor of an ocean alive with competing new forms of life.

SLIDE 11

There are three serious barriers[4] to entering that ocean on one side and emerging with a viable new form of life—a new enterprise based on new science—on the other side:

- Inventors, business managers, and venture investors do not share common motivations, language, or even trust.
- The research to reduce an innovative idea to practice and create product and process specifications that match a market is not the kind of science familiar to universities or the more incremental engineering practiced in established firms.
- That research is not often financed by either the S&T establishment or by the business investment establishment; it depends on a chaotic arrangement of angel investors, seed capital investors, bootstrapped investments by entrepreneurs and a very few experimental government programs, of which NIST's ATP is by far the most seriously thought out approach.

I regard the ATP program as a critical learning opportunity for government, in exploring the risks and rewards of the transition from invention to innovation and the government's role in reducing those risks while expanding the social returns to the entire economy. My research suggests to me that even at the current budget, well below that sought by President Clinton and far below the public funds spent on SBIR, ATP can make a big difference. Its effectiveness might be maximized if ATP can find excellent projects in states other than California, Massachusetts, Texas, and New York, and out of the more trendy fields such as biotech and information technology.[5] On that basis I believe the research Philip Auerswald and I are doing will find that ATP investments even at the current level would not be not small compared to private, early stage sources of research funding for high tech innovations.[6]

But quite apart from the stimulation ATP makes to new technologies and new values for society, it is also teaching a lot about the interplay of market and technology and the central role that product specifications play in the invention to innovation transition. This coupling of markets and science, through product specs, demands the kind of creative research we expect from our universities and the kind of disciplined choices we know we must make in our economy. This is where all our NBS and NIST experience in the characterization of materials and the making of accurate absolute measurements has taken us—right to the heart of the innovation process. Thus ATP should not be seen as something foreign to the NBS/NIST tradition, but something quite central to it. We mustn't lose it just when we begin to understand its true importance.

My next point is the importance of the integrity and legitimacy of the technical work that both sustains commerce and informs public decisions about the choices and uses of technology. As I told the Congress in its oversight hearings in 1972, the scientific integrity of the National Bureau of Standards is its most valuable technical asset. The committee agreed; its own independent investigation of the NBS concluded that the Bureau must be extraordinarily trustworthy and circumspect, since the investigator could not find any mention of the agency in the Congressional Record, except as related to the annual appropriation cycle.

The Bureau's integrity has, indeed, been tested and found solid. The ADX-2 challenge was only the most serious the Bureau's work had to face in its first 100 years. NBS/NIST has been the scientific adjudicator of a thousand disputes; it has very rarely been found wanting.

Why is does the laboratory have this reputation for integrity? Not just because its integrity has been tested and found strong. I believe it is because NBS/NIST has developed a culture that is committed to absolute measurement and respects the importance of quantifying systematic as well as statistical errors. This culture attracts scientists who want to do science that is too hard to do in a university. That is why I came from Harvard

[4] See L. M. Branscomb and Philip Auerswald, *Taking Technical Risks: How Innovators, Executives and Investors Manage High-Tech Risks* (Cambridge MA: MIT press) February 2001. This book is based, in part, on research funded by the NIST ATP program in which the MIT Entrepreneurship Program and experts in Entrepreneurship at the Harvard Business School participated. See L. M. Branscomb, Kenneth Morse and Michael Roberts, *Managing Technical Risks: Understanding Private Sector Decision Making in Early-Stage, Technology-Based Projects.* Advanced Technology Program, NIST, U.S. Dept. of Commerce, NIST GCR 00-787, April 2000.

[5] In 1999 76 % of all new venture capital funding went to biotech, IT and retail, and 67 percent went to ventures in California, Massachusetts, Texas, and New York. There is reason to believe that early stage seed funding was probably even more highly concentrated. ATP grants (throughout its history) averaged 39.6 % to these four states.

[6] Since angel and seed investors do not have to reveal their activities publicly, and the firms they invest in are almost all private, clear data are not available. But in 1998 one estimate of new seed venture capital investments was about $1.5 billion, of which only a small part was used for high tech R&D in states other than CA, MA, NY, and TX. Angel investments and bootstrapping by innovators with help from "family, friends, and fools" is estimated at $3–30 billion; again only a small part is high tech, and only a part of that is for R&D, and only a part is in states other than the leading four. Compare to ATP appropriations in 1998 of $ 192.5 million, down from a high of $340.5 million in 1995.

in 1951. NBS/NIST scientists understand the importance of being trusted as the disinterested expert in thousands of voluntary engineering standards committees, and adjudicating technical disputes for other agencies of the government. This culture must be sustained. It is rooted in the very best, often the most difficult, science. And of course, the leaders and the scientists of NBS/NIST do not play politics; we do not believe "the play of the marketplace" has any place in our lab notebooks.[7]

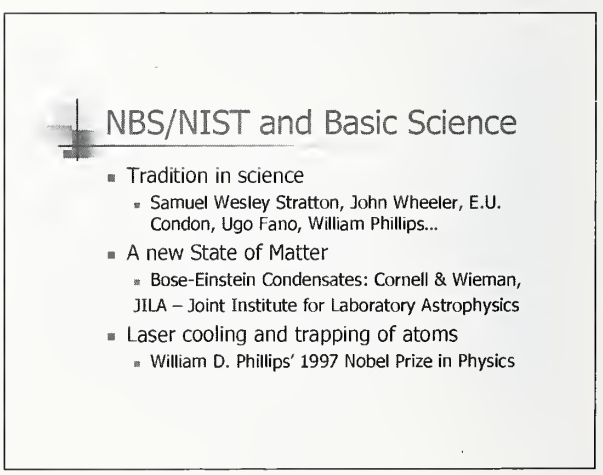
[Slide 12] Third, even though I have said NIST's legitimacy and integrity depend on freedom from political manipulation, NIST must demonstrate its political sophistication (a small "p," please) by creating the relationships of trust that allow it to be effective. I gave the example of the 1500 NBS scientists who served on industrial standards committees when I was director. Let me give you another example of how NBS/NIST create human institutions to further the value to the public of its technical services.

The Constitution (Article I, Section 8, Clause 5) gives the Congress the power to "fix the standards of weights and measures" for the nation. NBS might have asked to use that authority to control the weights and measures of the states. But it chose not to. Instead it serves as the secretariat of a National Conference of States on Weights and Measures, through which state officials voluntarily develop and ask their legislatures to adopt a common set of standards for weights and measures in commerce.

SLIDE 12

I am impressed by this model. During my directorship we began a similar process hoping to induce all 50 states to adopt common, performance-based building codes and standards, effectively consolidating some 13,000 code jurisdictions without depriving the states of their ultimate authority. The going has been slow, but there are many advantages to this consensual model. Today I wonder if a similar institutional invention might serve to give the nation harmonious but voluntary performance objectives and core curriculum content for public schools.

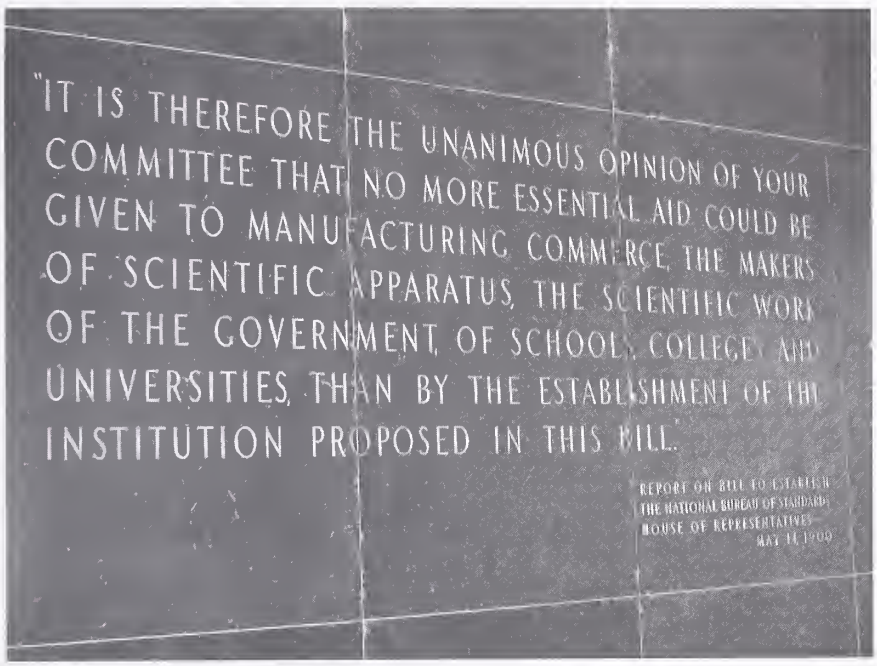
[Slide 13] Fourth and finally, I must reiterate that all of the value that NIST creates for our society depends critically and absolutely on the quality of its research. The special scientific culture at NIST is unique and irreplaceable. That research tradition should be expanded into understanding the socioeconomic processes that connect NIST activities to beneficial societal outcomes. The most critical events in the economy—the translation of science into innovations engage people with very different outlooks and expectations. The New Economic Growth theory and the new field of behavioral economics must help institutions like NIST to maximize their value to society. The NIST ATP economics research program, of which I am a beneficiary, has sponsored some of the most rigorous evaluation and policy research on the Invention to Innovation transition. It should be sustained and if possible expanded.



SLIDE 13

[7] The Senate Small Business Committee, in finding NBS at fault for concluding from a chemical analysis that ADX-2 consisted of Epsom and Glauber's salts that it was not useful to extend the life of automobile batteries, that NBS scientists had "failed to take into account the play of the market place." The implication is that NBS scientists should have given significant weight to anecdotes by motor pool operators who had tried the additive and believed it was helpful as they gave to the science of electrochemistry.

My final conclusion: this fine institution has served the nation with remarkable fidelity for almost half the life of the nation. It is the cornerstone of the Nation's science, and source of much of its industrial productivity, and now a major factor in finding new ways to foster the radical, science based innovations that Schumpeter understood but only our generation has seen to flower. [Slide 14] NIST's mission is not, alone, to serve the needs of industry in support of a strong economy; NIST's role is to support the scientific and technical enterprise of the nation in ways that expand its creativity, productivity, and utility to many dimensions of our national life. No other institution covers the full spectrum of service that NIST does and as the Congress so clearly anticipated in its statute of 1900 that led to the founding of NBS in 1901.



SLIDE 14

Closing Remarks

Richard F. Kayser
Director, Technology Services, National Institute of Standards and Technology

What a great talk, and what a fascinating day we have had! I would like to take just a few minutes to acknowledge some of the many people who have contributed to this meeting today.

I would like to start by acknowledging the five former directors of the National Bureau of Standards and NIST who were here today. Arati Prabhakar, who was here with us this morning, had to leave early, so she is not currently present. But, I would like to acknowledge again Lewis Branscomb—and the three others who are here now—Ernest Ambler, John Lyons—it's good to see John here—and Ray Kammer. Thank you very much for being with us today to celebrate our centennial.

I would also like to thank all of our speakers. I can't remember a meeting that I have attended where the quality of the talks has been so high, and where the presentations have been so thoughtful and thought provoking as we have had from our speakers today. I would like to thank all of them.

I would also like to thank all the people who participated in the panel discussion of the U.S. National Standards Strategy, as well as all of you who have shared the day with us today, and participated in the meeting in one way or another. Let's give ourselves a round of applause.

As I mentioned this morning, I really do want to thank Belinda Collins for putting together an excellent and stimulating program. I'm sure that any of you who put together a meeting like this know how difficult it is, and I think she did a fantastic job. Thank you, Belinda.

And last, but not least, there are a tremendous number of details that someone has to attend to make a meeting like this a success, and Mary Jo DiBernardo was the person who attended to all these details in a truly outstanding fashion, and I would like to thank Mary Jo for all her efforts.

Appendices

Appendix A

National Standards Strategy for the United States

American National Standards Institute

1 Introduction

Voluntary consensus standards for products, processes and services are at the foundation of the U.S. economy and society. The United States has a proud tradition of developing and using voluntary standards to support the needs of our citizens and the competitiveness of U.S. industry. The American National Standards Institute (ANSI), the coordinator of the U.S. standards system, has brought together public and private sector[1] interests to make this happen.

But the system is facing new challenges. Increasing global concern for health, safety and the protection of the environment combined with dramatic increases in world trade and competition from other countries have altered the standards landscape. At the national level, Congress has directed federal agencies to rely on voluntary consensus standards where compatible with their mission, raising the importance of national standardization processes for both the market and society.

[1] The word "sector" is used in two different meanings in this document. The first use divides the world into the "public sector" and the "private sector," distinguishing between the roles of government and non-government. The second use refers to a technology area where customer needs dictate a coherent and consistent approach to standardization. This use is sometimes called "industry sector" or "market sector" but we have chosen to use the simpler term "sector" to include all interested parties and not just commercial interests. Most standards are related to specific sectors (e.g., information technology, automotive) and are not applicable to the needs of other sectors.

II IMPERATIVES FOR ACTION

The standardization world has changed.

We can't assume that U.S. technology and practices will automatically be adopted everywhere, nor can we assume that within the U.S. everyone will be satisfied with "business as usual."

Internationally

- The European Union is aggressively and successfully promoting its technology and practices to other nations around the world through its own standards processes and through its national representation in the international standards activities of the International Organization for Standardization (ISO), the International Electrotechnical Commission (IEC) and the International Telecommunication Union (ITU).

- Emerging economies with the potential for explosive growth are looking to ISO and IEC for standards. In some sectors these standards do not reflect U.S. needs or practices.

The exclusion of technology supporting U.S. needs from international standards can be a significant detriment to U.S. competitiveness. The U.S. will lose market share as competitors work hard to shape standards to support their own technologies and methods. Equally important, standards are the basis for protection of health, safety and the environment. When our standards in these areas are not accepted elsewhere, we all lose.

At home

- U.S. public and private sector interests have reduced their investment in the development of globally accepted standards because of downsizing and deregulation.

- Customers of standardization want more for their money — a reduction in the duplication and overlap that sometimes results from a decentralized system, and better options for the delivery and utilization of standards.

- Government[2] agencies demand evidence that voluntary consensus standards meet high principles so that they can rely on them for both regulation and procurement.

[2] The word "government" in this paper means government in all places and at all levels. Where more specificity is intended, qualification is provided — thus "U.S. government" means the part or parts of the U.S. Government relevant to the discussion. The paper does not attempt to identify specific agencies and functions within any government designation beyond this.

III PRINCIPLES

U.S. interests strongly agree on the principles necessary for the development of national or international standards to meet societal and market needs.

In successful standards processes

- Decisions are reached through *consensus* among those affected.
- Participation is *open* to all affected interests.
- *Balance* is maintained among competing interests.
- The process is *transparent* — information on the process and progress is directly available.
- *Due process* assures that all views will be considered and that appeals are possible.
- The process is *flexible*, allowing the use of different methodologies to meet the needs of different technology and product sectors.
- The process is *timely*; purely administrative matters do not slow down the work.
- Standards activities are *coherent*, avoiding overlap or conflict.

Successful standards processes yield the right results

- Standards are *relevant*, meeting agreed criteria and satisfying real needs by providing added value.
- Standards are *responsive* to the real world; they use available, current technology and do not unnecessarily invalidate existing products or processes.
- Standards are *performance-based*, specifying essential characteristics rather than detailed designs.

IV Our Strategic Vision

U.S. leadership in implementing these principles nationally and internationally will turn visions into reality.

Internationally

- There is at most one globally applied standard and one globally accepted test, with conformity assessment processes appropriate to the needs of the parties, for each characteristic of a product, process or service.
- Governments use voluntary consensus standards in regulation and procurement.
- The system provides fair treatment for U.S. products and services, accommodating flexible standardization solutions.
- For some technology sectors, ISO and IEC are the preferred organizations within which to achieve one global standard. Other sectors utilize other organizations to achieve that goal. The U.S. confirms its commitment to contribute consistently and effectively in all international standardization activities.
- The standards development and delivery processes have been re-engineered to include full implementation of electronic tools, providing the potential for accelerating the work while reducing costs and making the resulting standards available in more convenient and responsive ways.

At home

- A cooperative process involving industry, government and consumers in the U.S. produces coherent and unified messages and well-coordinated U.S. positions internationally.
- All stakeholders participate in development of U.S. consensus positions.
- The coordination function of ANSI is strengthened to minimize duplication and overlap of national standards development and to develop coherence with international standards where beneficial. All materially affected interests recognize the importance of this function and support ANSI's role.
- Public and private sector management recognize the value of both national and international standardization and fund them appropriately.

V MOVING FORWARD

The strength of standardization in the United States is a sectoral focus supported by a dynamic infrastructure.

The sectoral focus comes from the participants — companies, government agencies, public interest organizations, talented individuals — who understand what is needed in their sector, and the standards developers through which they work to meet those customer needs. The sectoral approach allows interested parties to address their own issues and develop working methods that fit the problems at hand, since no single standardization system can satisfy all needs. This allows efficient standards development and fosters innovation and competition. When cross-sectoral issues arise, sector definitions change, or in venues where a single national voice is required, the infrastructure provided by the American National Standards Institute (ANSI) provides facilitation and mediation.

A sectoral approach recognizes that there is no simple recipe that can be handed down to fit all needs. Sectors must develop their own plans; the purpose of a national strategy is to provide guidance, coherence and inspiration to those inside and outside the system without constraining creativity or effectiveness. The U.S. National Standards Strategy therefore consists of a set of strategic initiatives having broad applicability which will be applied according to their relevance and importance to particular sectors. Stakeholders are encouraged to develop their own tactical initiatives where needed and the national strategy suggests some which have widespread applicability.

6

1 — Build on the trend in government to use voluntary consensus standards through existing public/private partnerships

Recent years have seen a dramatic increase in governmental reliance on voluntary consensus standards. Domestically, our vision is coming true because of cooperative public and private leadership. Public Law 104-113, the National Technology Transfer and Advancement Act of 1995 (NTTAA), is the cornerstone for this at the federal level, promoting increased use of voluntary consensus standards for both regulation and procurement. We are also making progress internationally; examples include re-engineering at the International Telecommunications Union (ITU) and NATO's use of voluntary consensus standards.

Further progress can be made as standards developers in all sectors work with the appropriate governmental agencies to increase use of the voluntary consensus process. In addition, new initiatives can increase the use of voluntary consensus standards at the state and local level to reduce the cost to the public, government and business (including conformity assessment) without compromising public interests. Tactical initiatives include:

- *ANSI* should provide state and local government with ways to easily identify where their interests are being addressed, and mechanisms for participating in overall policy development;
- *Standards developers* should work with governmental organizations to support increased use of voluntary consensus standards in their areas of expertise;
- *U.S. Government*, in addition to its ongoing efforts in support of the NTTAA, should provide leadership in intergovernmental activities at the regional and global levels for closer cooperation with voluntary consensus standards processes;
- *U.S. Government* should use existing relationships with state and local government and their responsibilities under NTTAA to support greater use of voluntary standards.

2 — Address the ongoing need for standards in support of health, safety and the environment

While U.S. standards have contributed significantly to improving safeguards for health, safety and the environment, the U.S. standards system must continue to incorporate technical excellence based on sound science. Tactical initiatives include:

- *Standards developers* should establish specific guidance to encourage participants to include health, safety and the environment as integral aspects of their work;
- *Government* should participate in standards development efforts to define technical specifications that meet public objectives, and encourage the same approach internationally;
- *Industry* should support participation in standardization nationally and internationally, and make sure that the resulting standards add value;
- *ANSI* should provide active coordination in the areas of health, safety and the environment for U.S. standards developers to ensure that the principles of openness, balance, due process and consensus are met;
- *ANSI and the standards developers* should also be proactive in international groups such as ISO, IEC and ITU that rely on national body representation.

3 — Improve the responsiveness of the standards system to the views and needs of consumer interests

The representation of consumer interests in standardization is important because standards are increasingly used to define parameters of products and services critical to consumers. Consumers have always been part of the U.S. standards development process, and principles such as openness and balance ensure that their voices can be heard. The U.S. standards system needs to continue to pay attention to consumers and make sure that their voices not only can be heard, but are heard. Tactical initiatives include:

- *Standards developers* should review consumer participation in their committees, determine if there is appropriate representation, and develop plans to address the results;
- *ANSI, standards developers and government* should establish initiatives to educate consumer organizations on investing in both technical and policy participation, and the methods available to do so;
- *ANSI* should explore with the standards communities of Canada and Mexico the possibility of establishing a regional body for consumer interests;
- *Industry* should use consumer research as the basis for standardization initiatives and decisions;
- *Government* should review its consumer-related programs and initiate standards information and participation programs where appropriate;
- *Consumer organizations* should establish programs to review information such as ANSI's *Standards Action* to identify areas where they need to be active.

4 — Broaden the U.S. standards "umbrella" to include all those organizations that are contributing to the standards system

Standards in the U.S. are developed by a variety of organizations ranging from those accredited by ANSI to special purpose industry consortia. This diversity is welcomed — the U.S. sees no need to force everyone into a single mold, and applauds the benefits that result. The U.S. process will be further strengthened when the talents of all these organizations are directed toward common objectives. As newer organizations develop their specifications, their work becomes the basis for action by the formal process when that adds value. Further linkages between these different types of organizations can therefore result in better standards. Tactical initiatives include:

- *Standards developers* should review their own operations to see if alternative processes such as those provided by leading U.S. standards developers to support non-traditional standards groups would further strengthen standardization in their sectors;
- *ANSI* should review its accreditation process to ensure that it adds value, and investigate its applicability to broader constituencies;
- *U.S. Government* should encourage more use of the principles embodied in accreditation by recognizing the ANSI process as providing sufficient evidence that American National Standards (ANS) meet federal criteria for voluntary consensus standards;
- *Non-traditional standards organizations* should review their objectives to determine where closer interaction with the formal system will help add value to their efforts;
- *Industry* should review its activities in all standards developers to improve the overall effectiveness of standardization.

5 — Work to improve processes internationally to more closely reflect our principles and vision

The U.S. recognizes that not all standards development reflects the ideals embodied in our principles and visions. Our objective, therefore, is for each part of the U.S. system to strive toward better implementation of those principles and visions and to work toward similar improvements where we participate outside the U.S. Tactical initiatives include:

- *Standards developers* in the U.S. who provide for international participation should make sure that all viewpoints, including those from developing nations, receive proper consideration;
- *ANSI* should take the leadership in ensuring that our principles and visions including the advantages of a sectoral approach and the desirability of globally accepted standards are addressed in regional organizations such as the Pacific Area Standards Congress (PASC) and the Comisión Panamericana de Normas Técnicas (COPANT);
- *U.S. Government* should, in its interactions with other governments, support process improvements and encourage them to provide similar support for their voluntary consensus standards developers.

The majority of U.S. participation outside the U.S. takes place in ISO and IEC and therefore deserves special attention. Reviewing the work now underway to re-engineer the ITU, for example, can help introduce new "best in class" processes. Tactical initiatives that should be undertaken by all organizations working in ISO and IEC — ANSI, standards developers, industry, and government — to further achieve the best standards to support trade and commerce while protecting health, safety and the environment include:

- Provide leadership in moving further a toward flexible sector-based structure and management;
- Provide leadership in further streamlining their processes and operations, including further alignment and consolidation of functions where possible;
- Provide leadership in advancing U.S. principles, and initiate change where needed;
- Work to develop alliances with industry, national standards bodies, and governments in other nations to ensure that best processes are adopted;
- Consider separating technical development of standards (by directly participating technical experts) from final approval (by national bodies), and review what organizational changes would be desirable;
- Review the Vienna and Dresden Agreements[3] and determine whether they still address the best interests of all parties;
- Consider whether the current "one nation, one vote" which ignores both decentralized and regional approaches to standardization — is still the most effective methodology for all sectors.

[3] The Vienna Agreement is a cooperative agreement between ISO and the European standards organization CEN that provides for development in one and approval, with parallel voting, in both. It also provides for ISO observers in CEN technical committees when work is being done there. The Dresden Agreement provides a similar framework for cooperation between IEC and CENELEC.

6 — Work to harmonize the use of standards worldwide as a tool for meeting regulatory requirements

For products, processes and services having an impact beyond the U.S., we seek at most one globally applied standard and one globally accepted test with conformity assessment processes appropriate to the needs of the parties. Tactical initiatives include:

- *Industry and government* should identify needed new standards and pursue global solutions;
- *Standards developers* should work with other standards bodies to identify existing standards in need of harmonization and pursue those changes;
- *U.S. Government* should work with governments in other countries, and through intergovernmental organizations, to minimize the use of different standards for the same purpose, different or duplicative tests for the same standards, and the use of standards as non-tariff trade barriers;
- *ANSI and government* should improve understanding of the use of voluntary consensus standards in regulation.

7 — Provide an outreach program to show those outside the U.S. the value of U.S. technology, standards and processes

The decentralized system in the United States is not well understood. Not only can this disadvantage U.S. interests, but the benefits of our system — flexibility and relevance to users — are not always recognized by global interests even when they represent a better solution. It is in our interests to make sure that everyone understands the strengths offered by the U.S. approach. Tactical initiatives include:

- *Standards developers* should initiate education processes worldwide for their sectors to ensure that opportunities for direct participation in U.S.-based activities are available to all;
- *Standards developers* should partner inside and outside the U.S. in areas of mutual interest such as health, safety and the environment;
- *U.S. Government* should increase the level of standards-related resources available to other countries, particularly those countries where U.S. industry is competing for key business or where the possibility for strategic alliances exists;
- *ANSI* should provide leadership in informing those in other countries of the benefits and results of U.S. standardization efforts, reinforcing complementary efforts by U.S. standards developers and U.S. Government agencies;
- *ANSI and standards developers* should provide leadership in coordination of sectoral initiatives with other nations.
- *Industry* should support the incorporation of U.S. needs in standards by working with industry outside the U.S.;
- *All participants* should work to make sure that those requiring standards in other nations understand the benefits of using the U.S.-based sectoral approach to meet their needs.

8 — Improve the standards process within the U.S. to address customer needs for efficiency

No system is perfect. While the sectoral approach does provide maximum flexibility, it can develop inefficiencies. All parties in the U.S. standards process should continue to improve. Tactical initiatives include:

- *Standards developers* should increase their use of information technology to improve the working processes for standards development and make those processes increasingly available to those participants whose resource limitations prevent the use of the "meeting and paper" model;
- *Standards developers* should work toward the use of compatible tools, so that participants working in more than one standards developer will have the benefit of common tools and systems;
- *Standards developers* should use standards distribution systems that meet the needs of today's customers, establishing, for example, cost-effective mechanisms such as alerting systems and flexible licensing agreements so that both small and large organizations can take better advantage of electronic availability;
- *ANSI* should provide a forum for standards developers to work together so that everyone can take advantage of "best in class" technologies and processes;
- *Industry and government* should encourage standards developers to emphasize these activities.

9 — Improve the standards process within the U.S. to address customer needs for coherence

A sectorally based, decentralized system can sometimes lead to overlap in work programs and occasionally to overlapping or conflicting standards. In many cases, this merely reflects a different set of customer needs for different sectors. However, we need to guard against duplication of efforts and results where it does not add value. Tactical initiatives include:

- *ANSI* should provide an "early warning" system to make sure that potential duplication can be identified as soon as possible and appropriately addressed, and provide facilitation and mediation services to effect a proper resolution;
- *ANSI* should review its procedures to make sure that standards receiving the ANS designation are relevant and do not conflict with other standards;
- *Standards developers* should work together to eliminate areas of redundancy, making the process more efficient as well as more coherent;
- *Industry* should be proactive at eliminating duplication by focusing their participation through fewer different organizations;
- *Government* should also be proactive through its participation and through development of early warning systems for proposed regulatory actions.

10 — Improve communications between various public and private elements of the U.S. standards system

A system with many partners can sometimes suffer from communications lapses. All participants in the U.S. should strive to improve both internal and external communications using advanced technologies. Tactical initiatives include:

- *Standards developers* should establish information dissemination mechanisms for interested parties outside their direct membership;
- *Government* should establish processes to ensure timely communication of standards related needs and activities — both internal ones and those in intergovernmental activities so that voluntary consensus processes can provide the best standards development support;
- *ANSI* should provide linkages between standards developers, government agencies, and others to ensure timely distribution of information to the widest possible audience.

11 — Make the value of standards development both apparent and real by educating public and private sector decision-makers about the value of standards and how to take advantage of the process

It is clear that management in both the public and private sectors are not sufficiently aware of the benefits of external standardization, or their current reliance on voluntary consensus standards, even when they are vigorously implementing standardization programs in their internal operations. An organized education process will provide broader participation, more effective participants, and higher quality standards. Tactical initiatives include:

- *Standards developers* should develop education programs for their sectors to address management and technical personnel in industry and government on the benefits of standardization;
- *ANSI* should develop a program to introduce standards and their effect on technology and trade into university curricula in business, engineering, and public administration;
- *Government* should develop and implement appropriate training programs for government personnel at all levels;
- *All participants* should develop case study evidence that demonstrates the value of relying on voluntary consensus standards in both regulation and procurement.

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12 — Establish a stable funding mechanism for the standardization infrastructure

Standards development systems around the world have in recent years come under increased financial pressure. The U.S. realizes that standards development must be a value-added process — if it meets public and private needs, then those who want the results will ensure that the necessary funding is provided. Tactical initiatives include:

- *Standards developers*, as part of their education initiatives, should provide economic examples of how the process works;
- *Government* should pay its fair share of the process costs, not just as a major participant, but as the representative of the broader public interest;
- *ANSI* should sponsor a summit on funding, giving all parties an opportunity to address alternative methodologies and best practices in light of the needs of all parties;
- *Industry* should take steps to ensure that standards development in their respective sectors is appropriately funded.

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VI

In The Longer Run

The proof of a strategy is in its execution. This document represents an architecture for achieving goals. The next step is for all concerned to address the tactical issues involved in making the strategy a reality. Doing so will require communication, cooperation and planning among all the concerned parties. The American National Standards Institute will continue to serve as a mechanism for coordinating, integrating, and reporting progress. ANSI should provide an annual report on actions taken in support of the strategy and, after a suitable time — perhaps three years — all of the parties to this strategy should reconvene to determine the progress that has been made, the actions needed to make further progress, and whether new situations dictate strategic revisions and offer new opportunities.

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was approved by the ANSI Board of Directors on August 31, 2000.

AMERICAN NATIONAL STANDARDS INSTITUTE

Headquarters
1819 L Street, NW
Sixth Floor
Washington, DC 20036
T: 202.293.8020
F: 202.293.9287

New York Office
11 West 42nd Street
New York, NY 10036
T: 212.642.4900
F: 212.398.0023
E: info@ansi.org
W: web.ansi.org

An electronic version of this text is available via ANSI Online (http://web.ansi.org/public/nss.html)

Appendix B
Panel Comments to Submitted Questions

Belinda Collins

1. *What is the Interagency Committee on Standards Policy (ICSP) in the Federal Government doing to implement the National Standards Strategy? What are NIST's plans?*

OMB Circular A-119 directs government to participate in the development of voluntary consensus standards and to use these standards in regulatory, procurement and other policy activities. In 1995, the National Technology Transfer and Advancement Act codified the Circular, and assigned NIST the responsibility to coordinate federal, state, and local standards and conformity-assessment activities with those of the private sector.

The ICSP chaired by NIST, leads the Federal shift to greater use of voluntary standards. Federal agencies have significantly increased their use of voluntary standards; withdrawn competing federal standards; and refrained from developing agency-unique standards. The National Standards Strategy provides important guidance for the ICSP and will shape future activities, both domestically and in government-to-government activities at all levels.

NIST and the ICSP are acting to reverse the decline in federal participation in voluntary standards activities. Agencies that use voluntary standards for regulatory or procurement purposes must continue to contribute their expertise and resources to the development and implementation of these standards.

2. *What would Federal Agencies like to see happen as a result of the Strategy, recognizing it as a positive step forward that addresses many issues of concern to the entire standards community?*

The ICSP has encouraged its members to examine the Strategy and to implement it as appropriate. Elements of the Strategy now filter through to individual agencies to guide standards-related activities. For example, federal agencies can do a better job of leveraging their relationships with state and local governments to encourage greater use of voluntary consensus standards. This, in turn, would help to reduce regulatory redundancy and duplicative testing requirements.

Some of the tools for this type of streamlining already are in place. In 2000, NIST issued guidance on conformity assessment to federal agencies. This document advocates intergovernmental efforts at all levels to remove unnecessary testing and certification requirements, which would improve the efficiency and transparency of domestic and export markets. The NIST Memorandum of Understanding (MOU) with the National Cooperation for Laboratory Accreditation (NACLA) commits NIST to encourage agencies at all levels to accept the use of laboratory accreditation bodies recognized by NACLA, and to encourage U.S. accreditors to seek NACLA recognition. For its part, NACLA commits to follow accepted international guides and standards and to accommodate relevant government requirements in the implementation of its recognition program.

Principles outlined in the National Standards Strategy closely match regulatory and procurement initiatives under way in many agencies, and are helping agencies identify additional opportunities for improvement. For example, the Strategy underscores the importance of consumer participation in standards activitiesconsistent with the core principles of consensus, openness, balance, and transparency. In response and where appropriate, agencies may wish to initiate standards information and participation programs for consumer-focused activities.

3. *What else is NIST doing to implement the National Standards Strategy? How can the private sector—specifically ANSI—help Federal Agencies?*

NIST has created an excellent working relationship with ANSI that is reflected both in our Memorandum of Understanding (MOU) and a broad range of joint activities. The MOU formalized our mutual agreement on the need for a unified national approach to develop the best possible national and international standards. It also affirmed our shared commitment to enhance and strengthen the U.S. national voluntary consensus standards system.

NIST is incorporating the National Standards Strategy principles into its own standards strategy. One of our goals is to provide technical leadership for the nation's measurement and standards infrastructure. This includes fostering and technically assisting the development of high-quality standards needed by government and industry. This goal

also includes cooperating with ANSI to improve the effectiveness and responsiveness of the national system for developing voluntary standards. Another element is increasing our work with international bodies to ensure that U.S. standards are understood and accepted by our trading partners.

A major focus of the National Standards Strategy is on increasing U.S. presence and leverage in international standards activities, and working to improve processes internationally to more closely reflect U.S. principles and vision. Looking at the international scene, current resources do not appear adequate to support the level of effort required to achieve the goals laid out in the Strategy and therefore effectively champion U.S. technology interests. The U.S. effort in standardization internationally is significantly underfunded in contrast to our major trading partners, particularly Europe, and the U.S. voice has not always been heard. ANSI's ability to participate in the broad range of ISO and IEC committees continues to be hampered by inconsistent support from the private sector and government. The limited resources of industry and government are frequently insufficient to provide representation at the grass roots level in standards development, representation that is critical to ensure consistency of international standards with U.S. standards and practices. We strongly support full government participation in the funding of ANSI's international activities, to ensure that U.S. interests are fully represented in ISO and IEC.

Bob Noth

1. *What has been the reaction of industry to the National Standards Strategy?*

I think the reaction of those companies that are already active in standards development has been very positive, with only few expressing comments that I would characterize as neutral. I know of only one trade association that expressed some concern with it. Because they were already participating effectively at the international level, they were concerned that having a public strategy might somehow undermine their particular effectiveness. I believe, however, that the vast majority of U.S. industry remains uninformed and unmoved.

This suggests the need for the strategy to be aggressively marketed and given "top billing" on the agendas of the major players in the standards community. ANSI's recent publication of their strategic plan built around the National Standards Strategy is an excellent framework to start with.

2. *How does industry plan to implement the National Standards Strategy?*

Based on discussions I've been involved with in various forums where industries come together, I'd say that it will vary from sector to sector, some being more proactive and aggressive than others. We all heard presentations today about the different approaches to national and international standardization and Larry Eicher talked about the reasons for "standards wars." This was anticipated in the Strategy, which was designed to be "inclusive" of various industry approaches and timetables.

My own company, Deere, is reformatting its standards strategy to utilize the terminology of the National Standards Strategy and is working with industry colleagues through our trade associations, key SDOs and ANSI to identify, prioritize, and coordinate the tactical approaches that will best serve our industry. Once we get our act together within our own sector and sub-sectors, we intend to harmonize our approach with those of other related sectors, like Aerospace, Automotive, and Discrete Part Manufacturers, to take advantage of any "synergies" that might exist.

3. *What advantages does industry see in having a National Standards Strategy that were not available before its publication?*

I can't answer for all industries but we at Deere and others I have talked to, see the National Standards Strategy as a cohesive force; a template for communication and coordination and a frame work for concentrated and concerted action on particular issues. We further believe the National Standards Strategy has an important function as a recruiting tool. There are too many non-participants that whether they recognize it or not, have a large stake in the game. It provides a common vocabulary that helps provide focus and promotes understanding. We could make those arguments before but we believe they now have more credibility because we can point to a top-level document that better defines standards importance to the national interest in commerce and trade as well as the roles of non-industry stakeholders.

Steve Oksala

1. *How can the U.S. standards "system" bring in all the consortia, fora, and other organizations?*

There are a variety of ways, depending on the needs of those organizations. Some may choose to become formally accredited once they understand the benefits; others may choose to partner with existing accredited organizations, either for administrative services or moving a standard to a higher level of consensus; still others would benefit by having an infrastructure in which they could interact with the formal process. Some, of course, do not need any of those things. Probably the biggest thing the "system" can do is to make sure that industry knows what is really available and how standards developers work, so that they can make knowledgeable choices about where to do technical harmonization.

2. *What's the biggest challenge to implementing the strategy?*

No question—it is getting the standards developers, companies, government, and everybody else to spend the energy to do better. The strategy is a framework for action. It provides ideas on how those with an interest in the standards "game" can move forward. It does not compel anyone to do anything, however, since it is rather like leading a horse to water.

3. *What would it mean to have more "coherence" in the system?*

At the very least, we should not be developing conflicting standards, or doing conflicting work, in ignorance. Ideally the various standards development efforts should be actively working together to make sure that our efforts are complementary.

4. *What should the U.S. Government do?*

First of all, participate. The U.S. government has a public interest role as well as a role as a very large purchaser of products that meet standards. It would also be useful, in my opinion, if the government recognized in a more positive way the ANSI system and the benefits it brings. At the very least, conformance to ANSI standards should mean presumption of conformance to documents such as the OMB Circular A-119.

5. *What can we do about the fact that the Europeans keep outvoting us?*

First of all, put in proposals that are good for everybody—then the Europeans will not vote no! However, where there are conflicts, get other countries to support our point of view by stressing that what we have is better for them. The ISO and IEC processes are based on representation by sovereign nations, and in the final analysis that won't change. Nor will the fact that there are a lot of countries in and near Europe whose best interests lie with supporting European standardization.

Gregory Saunders

1. *What makes the Department of Defense so interested in a National Standards Strategy?*

The Department of Defense has its own standards program and, through NATO and other alliances, its own interaction with other governments around the world. Yet DoD was not only an active participant in the development of the strategy, one of its high-level political appointees invited a delegation into the Pentagon to talk about the strategy and demonstrate support for it.

We live and operate in a global marketplace. It is vitally important to the Department that the U.S. industrial base be not just competitive, but be best in class. We recognize that industry is reliant on standards and so a standards strategy that helps to promote the competitiveness and leadership of U.S. industry helps the Department to gain access to the latest innovations so that we can maintain technological superiority. It also helps us to be able to support our troops from the commercial marketplace rather than from a manufacturing base that is unique to defense needs and is dependent on defense dollars for existence. Additionally, a national standards strategy, if properly implemented, should help the U.S. to maintain our economic security and that is a vital component of our national security.

2. *Now that the National Standards Strategy has been issued, what is the Department of Defense doing to implement it?*

The DoD continues to expand its use of non-Government standards. Through our MilSpec reform initiative, DoD has cancelled thousands of documents. In many cases, these have been turned over to the private sector where they really belong. The Department needs to devote resources to development and maintenance of standards that are unique to DoD needs, rather than on standards for products that are in regular use in the private sector. Addressing another of the points in the Strategy, we are working to develop sets of standardization case studies that will demonstrate the value of standardization. And, we are also working with ANSI and with various SDOs to evaluate and make recommendations to improve internal process and communications.

3. *At more than $100 Billion per year, the DoD is the largest single procurement organization in the country. Are there particular elements of the Strategy that you see as being more important of more urgent from a procurement point of view?*

There are a couple of areas of particular importance. As we continue to work toward greater reliance on non-government standards, the standards have to be written to address the needs of the Department. In some cases we can simply accept whatever the commercial world is doing, but in others we really need to participate on committees to be able to have our needs addressed. But with declining resources, we have fewer people to send to meetings and fewer dollars to send the people we do have. Therefore, process improvements are very important to us. Although we have an excellent voluntary standards system, we need to continually seek to improve the efficiency of the development process; through fewer "warm body" meetings; reduced overlap; and speed development by reducing the time from statement of need to publication of a standard.

Oliver Smoot

1. *What is the key to the success of the National Standards Strategy?*

It reflects and takes advantage of the distributed U.S. standards system. That is also the greatest challenge to our success, since it depends significantly on independent, voluntary, cooperative efforts.

2. *Is the National Standards Strategy all that the United States needs to do?*

No. Standards are important in themselves, and especially so in the United States where we basically have a small set of regulations and the rest is voluntary application of those standards that the producer thinks best for his product. But there is a significant amount of private sector as well as public sector conformity assessment in the United States and even more in the rest of the world. So, the needed complement to the National Standards Strategy is a National conformity Assessment Strategy. We hope, under Gerald Ritterbusch's leadership to accomplish that this year.

3. *What is ANSI's greatest challenge in doing its part to achieve the National Standards Strategy?*

ANSI needs to increase its base of support in the private sector through memberships and cooperative arrangements, so that is provides an active forum for discussing what we all need to do to accomplish the National Standards Strategy.

Jim Thomas

1. *How does the National Standards Strategy relate to the Technical Barriers to Trade (TBT) agreement on the important issue of international standardization?*

The TBT agreement states that, "Bodies operating with open, impartial and transparent procedures that afford an opportunity for consensus among all interested parties . . . contribute to prevent unnecessary obstacles to trade." Notably, an affiliation with a specific standards developer is not a requirement for the development of international standards. Within Annex 4, the WTO TBT Committee provides further clarity with regard to international standards by detailing a set of principles and procedures it considers important for international standards development. The principles listed are: transparency, openness, impartiality, effectiveness and relevance, and consideration of developing countries' concerns.

The National Standards Strategy is consistent with the TBT principles and procedures necessary for the development of international standards. First, it recognizes that the United States offers flexibility through multiple forums for the development of standards and that the affected stakeholders know the best forum to address their concerns. Second, the National Standards Strategy identifies the following principles as necessary for the development of international standards and urges U.S. leadership to implement these principles in whatever forum is utilized for standards development: consensus, openness, balance, transparency, due process, flexibility, timeliness and coherence. Finally, the National Standards Strategy urges provision of international education about the U.S. standards process, participation in standards development and consideration of international points of view, particularly from developing nations.

2. *Will the National Standards Strategy help reduce overlapping and redundant standardization activities?*

If the National Standards Strategy is successfully implemented, and stakeholders are permitted to continue choosing the solution that best meets their respective needs, reduced overlap and conflict will be natural outcomes.

The National Standards Strategy identifies "coherence" or the avoidance of overlap or conflict, as one of the components of a successful standards process both nationally and internationally. In the statement of international vision the National Standards Strategy calls for one globally applied standard and one accepted test method and it acknowledges that from a national perspective, cooperative processes that include all stakeholders will lead to a unified and coordinated international position. The National Standards Strategy strategic initiatives that facilitate the reduction of overlap and redundancy include:

- Support the trend for government use of voluntary consensus standards
- Improve international processes to more closely reflect U.S. principles and vision and achieve the best standards for commerce and trade
- Facilitate the use of standards worldwide as a tool to meet regulatory requirements
- Demonstrate the value of U.S. technology, standards, and processes
- Enhance the process to ensure that customer needs for coherence are addressed
- Improve communications of needs as well as existing solutions to avoid overlap.

More importantly, the key determinants in a given standard's ability to be globally accepted and applied are/should be directly related to the standard's market relevance, technical currency, and responsiveness to innovation. If the market determines that an existing standard meets these criteria, the need for alternatives and duplicates is naturally minimized.

3. *Do you envision significant changes in SDO process and business models based on the "Moving Forward" concepts contained in the National Standards Strategy?*

The National Standards Strategy recognizes ". . . no single standardization system can satisfy all needs." Due to this inherent diversity, the degree of change required will really depend on each developing organization. While the National Standards Strategy identified such strategic initiatives as consumer participation, improved international processes, and better processes for efficiency and coherence, it is essential for developers, on their own initiative, to regularly evaluate their process and business models for strategic and commercial reasons and to modify them accordingly.

With regard to processes, we, collectively as standards developers, are lucky. Today's technology affords SDOs the ability to reach out to more stakeholders than ever before and to do so efficiently and economically. Implementation of technology has become necessary as the community of affected participants becomes increasingly global, the resources available to conduct the often-voluntary standards development work decrease, and the demand for accelerated delivery increases. Today's technology facilitates participant outreach, economical draft distribution, timely collection of global input, accelerated publication, and worldwide dissemination of the finished product. Regarding changes to business models, it is safe to say that each organization has selected one. As there are a variety of standardization systems, so there are corresponding business models that support the respective organization with the generation of revenues from a variety of sources. What is most important is not that the National Standards Strategy necessitates a change to these business models, but that it allows the variety of business models to continue and does not diminish their ability to flourish.

Appendix C
Biographies

HOWARD M. BLOOM

Mr. Bloom received a B.E.S. from Johns Hopkins University in 1965, and a M.S. degree from the University of Maryland in 1967, both in Electrical Engineering. Mr. Bloom has over thirty-six years of experience in the application of information technology to engineering applications with the last 20 years specifically in manufacturing engineering.

Since December 1980, Mr. Bloom has been at the National Institute of Standards and Technology (previously the National Bureau of Standards), an agency of the Department of Commerce. In the early 1980's he was responsible for the development of the information infrastructure that supported the Automated Manufacturing Research Facility (a collection of machining and inspection workstations integrated through a factory network tied to a distributed database environment). From 1984 to 1996, Mr. Bloom was Chief of the Manufacturing Systems Division and directed research and development of Computer Integrated Manufacturing (CIM) applications and interface specifications in the areas of design, process planning, production control and the information infrastructure to support these applications (e.g. distributed database systems and factory networks). During that period, he was instrumental in the development and implementation of the international product data exchange standard known as STEP. For the next three years, he was Deputy Director of the Manufacturing Engineering Laboratory, and in July, 2000 became Acting Director of the Manufacturing Engineering Laboratory.

In this new role, he has the responsibility for satisfying the measurements and standards needs of the U.S. discrete-part manufacturers in mechanical and dimensional metrology and in advanced manufacturing. He serves on several industry and standards boards such as PDES, Inc., USPRO, and IMTI. The laboratory has focussed efforts in basic metrology, manufacturing interoperability, first part correct, and meso/micro/nano manufacturing.

LEWIS M. BRANSCOMB

Lewis M. Branscomb is Aetna Professor of Public Policy and Corporate Management (emeritus) and is emeritus director of the school's Science Technology and Public Policy Program in the Belfer Center for Science and International Affairs.

A research physicist at the U.S. National Bureau of Standards (now the National Institute for Standards and Technology) from 1951 to 1969, he was then appointed Director of NBS by President Nixon, and served to 1972, when he was named vice president and chief scientist of IBM Corporation, serving until he retired and joined the Harvard faculty in 1986. While at NBS Branscomb was editor of the Reviews of Modern Physics, chief of the Atomic Physics Division, and co-founded JILA, a partnership research venture between NBS/NIST and the University of Colorado in Boulder.

Dr. Branscomb received the BA in physics, *summa cum laude,* from Duke University in 1945 and PhD in physics from Harvard in 1949, when he was appointed Junior Fellow in the Harvard Society of Fellows. He is a director of Lord corporation and is a trustee of Vanderbilt University, Woods Hole Oceanographic Institution, and the National Geographic Society. From 1984 to 1986 was an Overseer of Harvard University.

Branscomb was appointed by President Johnson to the President's Science Advisory Committee (1964-1968) and by President Reagan to the National Productivity Advisory Committee. In 1980 President Carter appointed him to the National Science Board and in 1980 he was elected chairman serving until May 1984. He is a member of the National Academy of Engineering, the National Academy of Sciences, the Institute of Medicine and the National Academy of Public Administration. He is a director of the AAAS, a Councilor of the National Academy of Sciences, and a member of the Governing Board of the National Research Council.

He is recipient of the Arthur Bueche Award of the National Academy of Engineering, the Gold Medal of the U.S. Department of Commerce, and most recently the Okawa Prize in Communications and Informatics. He holds honorary doctor of science degrees from fifteen universities and is a honorary associate of the Engineering Academy of Japan.

Prof. Branscomb has written extensively on information technology, comparative science and technology policy, and management of innovation and technology. His most recent book, authored with Philip Auerswald, is

Taking Technical Risks: Innovators, Executives and Investors Manage High Tech Innovations. This book is based on studies performed for the NIST ATP program and is published by MIT press just last month. He and Auerswald are currently engaged in a follow-on study for ATP, tracing the sources of finance for the transition from invention to innovation.

Appendix:

Other recent books written or edited by LMB are: *Industrializing Knowledge: University- Industry Linkages in Japan and the United States* (edited with Fumio Kodama and Richard Florida, 1999); *Investing in Innovation: A Research and Innovation Policy that Works* (edited with James Keller, 1998); *Korea at the Turning Point: Innovation-Based Strategies for Development* (with H.Y. Choi, 1996); *Japanese Innovation Strategy: Technical Support for Business Visions* (with Fumio Kodama, 1993); *Empowering Technology: Implementing a U.S. Policy* (1993); *Converging Infrastructures: Intelligent Transportation and the National Information Infrastructure* (with James Keller, 1996); *Informed Legislatures: Coping with Science in a Democracy* (with Megan Jones and David Guston, 1996); *Confessions of a Technophile* (1994); and *Beyond Spinoff: Military and Commercial Technologies in a Changing World* (with J. Alic, et.al., 1992).

BELINDA L. COLLINS

Belinda L. Collins is the Director of NIST's Office of Standards Services, which provides policy support for standards and conformity assessment activities for Federal agencies. OSS administers programs in Laboratory Accreditation, Technical Standards Activities, Global Standards, and Standards Information, as well as the implementation of the National Technology Transfer and Advancement Act of 1995. Dr. Collins chairs the federal Interagency Committee on Standards Policy (ICSP), and is the immediate past chair of the International Laboratory Accreditation Cooperation (ILAC), as well as a former chair of the National Cooperation for Laboratory Accreditation (NACLA).

Dr. Collins received her M.A. and Ph.D. in experimental psychology (visual psychophysics) from the University of Virginia, and her B.A. in experimental psychology from Mary Washington College. While at NIST, she has served in several different positions, including research psychologist, Leader of the Lighting Group, Program Analyst in Office of the NIST Director, and Director of the Office of Standards Serivces. Dr. Collins has authored numerous technical publications and has been active in both domestic and international standardization. Dr. Collins is a Fellow of the Illumination Engineering Society of North America (IESNA) and served as its Vice President for Education (1995-1997). Dr. Collins received the NIST Bronze Medal in 1984 and the NIST Rosa Award in 2000. In 1997, she received a Meritorious Service Award from the American National Standards Institute, and a Public Service Award from ACIL. In 2000, she received the Lifetime Achievement Award from NACLA.

LAWRENCE D. EICHER

Dr. Lawrence D. Eicher became the Secretary-General of the International Organization for Standardization (ISO) in May 1986. He is the Chief Executive Officer of the Organization which has its headquarters in Geneva. Before joining ISO as Assistant Secretary-General in 1980. Dr. Eicher was Director of the Office of Engineering Standards at the National Bureau of Standards of the United States.

Dr. Eicher's career includes twenty-five years in educational, scientific, technical and administrative work. A native of Colorado (USA) he received a doctorate degree in physical chemistry at Texas A&M University in 1972 and continued his career with the National Science Foundation in Washington D.C. He is the author of numerous scientific papers, and a textbook on chemical analysis. He joined the National Bureau of Standards (USA) in 1974, and from that time he has been closely associated with international standardization.

STEPHEN W. FREIMAN

Dr. Stephen W. Freiman is Chief of the Ceramics Division at the National Institute of Standards and Technology (NIST) in Gaithersburg, MD.

Dr. Freiman graduated from the Georgia Institute of Technology with a B. ChE. and a M. S. in Metallurgy. He received a Ph.D. in Materials Science and Engineering from the University of Florida. Upon receiving his doctoral in 1968, Dr. Freiman worked at the IIT Research Institute and the Naval Research Laboratory. He joined NIST (then NBS) in 1978. Prior to becoming Chief of the Ceramics Division he served as Group Leader of the Electronic Materials Group in the Ceramics Division. Dr. Freiman has published over 150 papers focussing on the mechanical properties of brittle materials.

Dr. Freiman is a Fellow and a Past President of the American Ceramic Society (ACerS).

MATHIAS FÜNFSCHILLING

Mr. Funfschilling became President of the IEC on 1 January 1999 and was Treasurer from 1990-96. He is President and CEO of MGC Moser-Glaser Group. His recent career includes development work in plasma ultra-high temperature technology. He is past president of the Swiss NC and is a board member of the VSM Swiss Industry Board.

KATHARINE BLODGETT GEBBIE

Katharine Blodgett Gebbie is Director of NIST's Physics Laboratory, which supports U.S. industry, government and the scientific community by providing measurement services and research for electronic, optical and radiation technologies. Its focus on atomic, molecular, optical and radiation physics reflects the continuing importance of these disciplines in developing new measurement technology.

Dr. Gebbie graduated from Bryn Mawr College with a B.A. degree in physics and subsequently earned a B.S. degree in astronomy and a Ph.D. in physics from University College London. She joined NIST in 1968 as a physicist in the Quantum Physics Division of JILA, a cooperative enterprise between NIST and the University of Colorado in Boulder. She has worked extensively on the physics of the solar and stellar atmospheres. Before being appointed Director of the newly formed Physics Laboratory in 1991, she served as Chief of the Quantum Physics Division and Acting Director of the Center for Atomic, Molecular and Optical Physics.

Dr. Gebbie is a Fellow of the American Physical Society, a Fellow of JILA, and a member of several professional societies including Sigma Xi and American Women in Science. She has served as Vice President of the International Committee on Weights and Measurers and as President of the Consultative Committee on Temperature. She has received several awards, including the Department of Commerce Gold Medal, the Women in Science and Engineering (WISE) Lifetime Achievement Award, and the Washington Academy of Sciences Award for Outstanding Contributions to the Physical Sciences.

CASEY C. GRANT

Casey C. Grant, P.E. is assistant vice president of Code & Standards Administration and assistant chief engineer at the NFPA, where his responsibilities include oversight for the nearly 300 NFPA codes and standards. In addition, Casey is also Secretary to the NFPA Standards Council, which is the primary administrative body of NFPA's codes and standards system. The NFPA is a non-profit membership organization established in 1896 with approximately 70,000 members from around the world dedicated to the cause of safety.

Casey has a Bachelor of Science degree from the University of Maryland and a Master of Science degree from Worcester Polytechnic Institute, both in Fire Protection Engineering. Among his other duties, he currently serves as Vice-Chair of the Executive Standards Council of the American National Standards Institute (ANSI). Casey is a Registered Professional Engineer in Fire Protection Engineering in the states of California and Tennessee, and is a member of both the Beta and Gamma Chapters of the Salamander Fire Protection Honorary Society.

Casey has given numerous presentations on fire safety around the world, and he is the editor for the fire safety section of the ILO Encyclopedia on Occupational Health and Safety. He is a member of the USA Branch of the Institute of Fire Engineers, and holds a member grade in the Society of Fire Protection Engineers. Casey has one safety related U.S. Patent, and he is a recipient of an award from the United States Environmental Protection Agency for his work helping to implement alternatives for the world-wide phase-out of CFCs and halons.

MICHAEL D. HOGAN

Michael D. Hogan is responsible for liaison with the voluntary standards community for the Information Technology Laboratory (ITL) at the National Institute of Standards and Technology (NIST). He represents NIST at national and international voluntary standards organizations that manage the development of standards and associated testing methodologies for information technology (IT), and he participates in the development of policies on standards and conformity assessment issues.

In 1996, he convened an inter-laboratory study group at NIST to explore the concepts of metrology and their application to information technology systems, and to relate measurements in IT to established metrology theories, such as traceability. The group's study was published in May 1997 as NISTIR 6025, *Metrology for Information Technology*.

From 1994 to 1997, Mr. Hogan chaired the Information Systems Standards Board of the American National Standards Institute. He is past vice chairman of the JTC 1 TAG Advisory Committee (1988 to 1992). Mr. Hogan has

served as a member of the JTC 1 TAG since its inception in 1988. The JTC 1 TAG represents the U.S. in the development of international IT standards within ISO/IEC Joint Technical Committee 1 on Information Technology. From 1987 until the present, he has represented NIST at the management and policy level on the National Committee for Information Technology (NCITS), previously the Accredited Standards Committee X3, Information Technology. From 1975 to 1989, Mr. Hogan was the principal technical expert representative from NIST to several X3 Technical Committees, including B1 (Digital Magnetic Tape), B5 (Magnetic Tape Cassettes and Cartridges), and B8 (Flexible Disk Cartridges). He served as the International Representative for these Technical Committees from 1979 to 1989. Mr. Hogan also served as the U.S. Head of Delegation to ISO/IEC JTC 1/SC 11, Flexible Magnetic Media for Digital Data Interchange, from 1979 to 1989.

Mr. Hogan has been a member of the NIST staff since 1974. From 1982 to 1987, he managed the Computer Storage Media Group, which conducted research in methods to characterize and measure magnetic and optical digital data storage media. In previous positions at NIST, he developed reference measurement services and data interchange standards for computer storage media.

Mr. Hogan graduated with honors (member of Eta Kappa Nu) with a B.S. degree in electrical engineering from the University of Maryland in 1973. In 1967, he was a Distinguished Graduate of the Infantry Officer Candidate School at Fort Benning, Georgia. During 1968 and 1969, Lieutenant Hogan served in Vietnam as an executive officer, an operations officer, and a platoon leader for U.S. Army units attached to the 199th Light Infantry Brigade and to the 1st Infantry Division.

MARK W. HURWITZ

Dr. Mark W. Hurwitz, CAE, was named President and CEO of the American National Standards Institute (ANSI) by its Board of Directors on July 1, 1999.

ANSI is a not-for-profit membership organization that brings together organizations from both the private and public sectors dedicated to furthering U.S. and international voluntary consensus standards and conformity assessments. ANSI accredits national standards developing organizations and approves American National Standards. It is the sole U.S. representative to the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC), via the U.S. National Committee.

Before joining ANSI, Dr. Hurwitz served as chief executive officer and executive vice- president of the American Institute of Architects (AIA). He is a past executive vice- president of the Building Owners and Managers Association International (BOMA) and a former senior vice-president and chief operating officer of the National Association of Professional Insurance Agents. Dr. Hurwitz, who founded the Center for Association Leadership in Princeton, N. J., an association management consulting firm, is a frequent speaker at association management symposia and has been a guest professor at several colleges and universities.

Dr. Hurwitz earned a doctorate in administration from Temple University in Philadelphia. He and his wife, Josette, reside in Alexandria, Virginia.

RAYMOND KAMMER

Raymond Kammer was nominated by President Clinton on September 4, 1997, to serve as Director of the National Institute of Standards and Technology. After being confirmed by the U.S. Senate, he took office on November 12 and remained as Director of NIST until his retirement in December 2000. An agency of the U.S. Commerce Department's Technology Administration, NIST promotes U.S. economic growth by working with industry develop and apply technology, measurements, and standards. As NIST Director, Mr. Kammer oversaw a staff of approximately 3,300 and a budget of about $700 million. More than half of the staff is composed of scientists and engineers located at the NIST campuses in Gaithersburg, Maryland, and Boulder, Colorado.

Previously, Mr. Kammer served on an acting basis as the Chief Financial Officer, the Assistant Secretary for Administration and the Chief Information Officer for the Department of Commerce. As Deputy Director of NIST from 1980 to 1991 and 1993 to 1997, Mr. Kammer was responsible for the day-to-day operation of the Institute and for long-range planning and policy development. The primary mission of NIST is to promote U.S. economic growth by working with industry to develop and apply technology, measurements, and standards. This mission is accomplished through four major programs:

- Measurement and Standards Laboratories focused on "infrastructural technologies," such as measurements, standards, evaluated data and test methods;

- a competitive Advanced Technology Program that provides cost-shared awards to industry for development of high-risk, enabling technologies with broad economic potential;

- a grassroots Manufacturing Extension Partnership with a network of local centers offering technical and business assistance to smaller manufacturers; and

- a highly visible organizational improvement program associated with the Malcolm Baldrige National Quality Award.

From 1991 to 1993, Mr. Kammer was Deputy Under Secretary of Commerce for Oceans and Atmosphere in NOAA. In that position, he served as NOAA's Chief Operating Officer and was responsible for overseeing the technical projects of this $2 billion agency which has a staff of over 14,000. NOAA has five major programs—the National Weather Service; the National Marine Fisheries Service; the National Environmental Satellite, Data, and Information Service; the National Ocean Service; and the Office of Oceanic and Atmospheric Research.

Mr. Kammer began his career with the Department of Commerce in 1969 as a program analyst. Prior to his appointment as Deputy Director of NIST, Mr. Kammer held a number of positions at NIST and in the Department of Commerce involving budgetary and program analysis, planning and personnel management. During his tenure as Deputy Director, he also held positions as Acting Director of NIST, Acting Director of the National Measurement Laboratory at NIST, and Acting Director of the Advanced Technology Program at NIST.

Mr. Kammer has chaired several important evaluation committees for the Department of Commerce, including reviews of satellite systems for weather monitoring and the U.S. LANDSAT program, and of the next generation of weather radar used by the U.S. Government. He also served on the Board of Directors of the American Society for Testing and Materials, a major international society for the development of voluntary standards for materials, products, systems, and services.

His awards include both the Gold and Silver Medals of the Department of Commerce, the William A. Jump Award for Exceptional Achievement in Public Administration, the Federal Government Meritorious Executive Award, and the Roger W. Jones Award for Executive Leadership.

Mr. Kammer received his Bachelor of Arts degree from the University of Maryland in 1969.

RICHARD F. KAYSER

Dr. Kayser received a Sc.B. in physical chemistry from Brown University in June 1973 and a Ph.D. in physical chemistry from Rice University in May 1976. He moved to the National Bureau of Standards (now the National Institute of Standards and Technology) in May 1976 as a National Science Foundation Postdoctoral Fellow and joined the Thermophysics Division as a permanent staff member one year later.

Over the next ten years, Dr. Kayser performed research on a wide variety of theoretical and experimental topics, ranging from phase transitions to wetting phenomena. During that time, he published approximately 40 papers in the peer-reviewed archival literature.

Dr. Kayser became Chief of the Thermophysics Division in May 1989 and Chief of the Physical and Chemical Properties Division in May 1996. In these positions, he was responsible for NIST's programs on the thermophysical and thermochemical properties of gases, liquids, and solids; the rates and mechanisms of chemical reactions in the gas and liquid phases; process separations and low-temperature refrigeration, heat transfer, and flow; and pressure, vacuum, and low-flow-rate measurements and standards, including the U.S. national standards in those areas.

Dr. Kayser assumed the position of Director of Technology Services in August 1999. Among its activities, Technology Services supports the NIST Measurement and Standards Laboratories in the provision of calibrations, Standard Reference Materials, and Standard Reference Data; promotes accuracy and uniformity throughout the States in weights and measures; conducts the National Voluntary Laboratory Accreditation Program; and facilitates trade by promoting the efficient development and use of U.S. standards and technology and by reducing technical barriers to trade.

JUNE LING

As Associate Executive Director, Codes and Standards, June Ling is responsible for the codes, standards, and conformity assessment activities of the American Society of Mechanical Engineers (also known as ASME International).

Ms. Ling joined the Society's technical codes and standards staff in July 1974 and holds a B.S. in Physics. Prior to becoming Associate Executive Director, Ms. Ling served as Managing Director, Operations, during which time she was responsible for the publication and sales of ASME codes and standards and the administration of the Society's accreditation and certification activities, including the establishment of ASME as an accredited ISO 9000 registrar program.

Her previous positions at ASME included Director, Pressure Technology Codes and Standards [1990–1992], Director, Nuclear and Safety Codes and Standards [1985 – 1990], and Director, Nuclear Codes and Standards [1980 – 1985].

During her 26 years with the Society, Ms. Ling served on various ASME committees and supervisory boards and interacted with government agencies, industry and standards developing organizations around the world.

Ms. Ling serves on the Board of Directors of the American National Standards Institute and the Board of Directors of the Uniform Boiler and Pressure Vessel Laws Society. She is a member of the Industry Functional Advisory Committee on Standards for Trade Policy Matters (IFAC 2) under the Department of Commerce and USTR, and is a Fellow of the Standards Engineering Society and an ASME Fellow.

MARY C. MCKIEL

Dr. McKiel began her Federal career in 1976 as an analytical chemist at the *National Archives and Records Service* (now an independent Administration). There, she developed chemical methods for restoring and preserving textual and non-textual materials. As a member of the US Group to ISO Technical Committee (6) on Paper, she participated in developing international standards for archival quality paper.

From 1982 to 1993, Mary served in several capacities at the *Federal Supply Service of the General Services Administration*: Chief of Engineering and Standards Policy, Director of Quality Standards, and Director of Environmental Planning. At GSA, among other achievements Mary instituted and managed quality control and assurance programs for the Service, and developed and published GSA's first "green" catalog. She earned several Outstanding Service awards and medals while at GSA.

In 1993, she joined the *Environmental Protection Agency* in the Office of Prevention, Pesticides and Toxic Substances. With the approval of EPA's Administrator, she initiated and managed the EPA's first cross-office program for voluntary standards. As Director of the EPA Standards Network, she coordinated Agency use of non-government standards and managed EPA's participation in the US Technical Advisory Group (TAG) for the development of the ISO 14000 standards for Environmental Management. She was elected Vice Chair of the US TAG and continues to serve in that capacity.

In 1998, Mary was appointed by to the position of EPA Standards Executive. As such, her role is Agency-wide in responsibility and includes implementing the National Technology Transfer and Advancement Act and OMB Circular A-119 throughout EPA. She heads up the Agency's Standards Program and represents the Agency on the Interagency Committee for Standards Policy. Mary represents EPA standards policies in national, regional and international standards-related fora, the International Organization for Standardization (ISO), the Pacific Area Standards Congress (PASC) and the South American Congress for Norms and Technical Standards (COPANT). She has earned the 1998 EPA Administrator's Silver Medal for Excellence in Service, as well as Silver and Bronze Agency medals from 1996 to the present.

Mary currently serves as a Vice Chair on the Board of Directors of the American National Standards Institute (ANSI) and is immediate past Chair of ANSI's Government Member Council. She has served on the Board of Directors for the International Policy Institute in Washington and represented the US in international environmental discussions involving standards through the United Nations Environmental Program (UNEP) and the United Nations Committee on Trade and Development (UNCTAD) as well as in the Organization for Economic Cooperation and Development (OECD).

Mary has numerous publications on standards and standards in regulations and regularly makes national and internationally presentations on standards-related topics.

ROBERT W. NOTH

As Manager of Engineering Standards for Deere & Company, Bob Noth is responsible for overseeing the development, deployment, utilization and administration of standards affecting the Deere product line worldwide. This includes responsibility for development and implementation of strategies and processes that effectively avoid redundant and/or unnecessary parts and components from entering Deere's products and product support system.

A graduate of the University of Dubuque with a BA in mathematics, Bob joined Deere in 1965 as an Industrial Engineer at the Dubuque Works. At Dubuque he held positions in IE, Value Analysis, Production and General Supervision and as a Division Engineer in IE installed the Deere Incentive System as part of the start up of the Davenport Iowa Industrial Equipment Factory. In 1976 Bob transferred to Corporate Headquarters as a Division Manager in IE, responsible for Incentive System integrity and grievance investigation. From 1977 to 1985 he managed Industrial and Assembly Process Engineering in Deere's Horicon, Wisconsin Factory in the Commercial and Consumer Equipment Division. He returned to corporate headquarters in 1985 as a Senior Division Manager in Industrial Engineering responsible for indirect labor and office productivity improvement programs. In 1989 he became the Manager of Parts Standardization Programs. He assumed his current position in the July of 1992.

Bob is active in several professional societies and standards developing organizations. He is a past chair of the SAE TechnicaI Standards Board and is currently on the SAE Board of Directors. He sits on committee PM 03 of the American Society of Agricultural Engineers (ASAE) and retains his membership in the Institute of Industrial Engineers (IIE). He became involved with the ANSI Company Member Council Executive Committee in 1991 and served as its Vice Chair from 1992 until 1997. He was Vice Chair of the ANSI Standards and Data Services Committee (SDSC) during the development of the NSSN and represented the U.S. on the joint ISO/IEC Information Technology Strategy Coordination and Implementation Groups. He served as head of the ANSI delegation to the ISO Information Committee (INFCO) for 3 years as part of duties in the SDSC. He also participated on the ad hoc advisory group to ANSI during the latest re- negotiation of the POCOSA agreement. He currently represents Deere & Company on ICSCA, the International Cooperation on Standards and Conformity Assessment.

STEPHEN P. OKSALA

Mr. Oksala is the Vice President of Standards for the Society of Cable Telecommunications Engineers (SCTE). In this position he is responsible for a wide- ranging standards program for the cable telecommunications industry covering topics from connectors to cable modems. Prior to joining SCTE at the beginning of 2001 he spent 35 years with the Unisys Corporation, including 13 as Director of Standards and Regulatory Compliance. He also held management positions in system design, hardware design, operating systems and languages, and applications development.

Mr. Oksala has been a member of the Board of Directors of the American National Standards Institute since 1990. He chairs the Board National Issues Committee, which is responsible for domestic standards and government relations policy, and is a member of the International Committee and Board Committee on Conformity Assessment.

Mr. Oksala was the 1999 recipient of the ANSI Edward Lohse medal for standardization in Information Technology and has twice (first place in 1996 and second place in 2000) won awards in the World Standards Day paper contest. He has testified before Congress on several occasions on the subject of standards and conformity assessment and the role of government in these processes.

Mr. Oksala holds a BSEE from the University of Michigan, and an MBA from Wayne State University, and resides with his wife Junede in Exton, Pennsylvania.

ARATI PRABHAKAR

Arati Prabhakar is a venture partner at U.S. Venture Partners in Menlo Park, California. From 1986 to 1993, Arati worked at the Defense Advanced Research Projects Agency, initially as a program manager and subsequently as director of the Microelectronics Technology Office. In 1993, President Clinton appointed Arati as the director of the National Institute of Standards and Technology. Arati joined Raychem Corporation as senior vice president and chief technology officer in 1997. She was subsequently vice president and then president of Interval Research Corporation, which she joined in 1998.

Arati received her B.S. in Electrical Engineering from Texas Tech University. She received an M.S. in Electrical Engineering and a Ph.D. in Applied Physics from the California Institute of Technology. Arati began her career as a Congressional fellow at the Office of Technology Assessment. She is a Caltech Distinguished Alumna and a Texas Tech Distinguished Engineer. Arati is a Fellow of the Institute of Electrical and Electronics Engineers.

ED RONEY

Ed Roney has been with Motorola since 1978, first as IPR Counsel for Motorola's communications businesses, and now as Corporate Vice President and Director of Standards and Technology Transfer.

Prior to Motorola, Ed was with Schlumberger, Ltd. as Patent Counsel, Oilfield Services Sector. He started his career as an engineer with Martin Marietta and later as a patent examiner in the computer section of the U.S. Patent Office.

He has a law degree from Georgetown University and electrical engineering degree from the University of Virginia. He was admitted to practice law in Washington, D.C. and Texas and to practice before the U. S. Patent and Trademark Office.

He is a member of the Board of Directors of ITI and IEEE-ISTO and a member of various other associations. He is chairman of ITI's Committee on Standards, Technology and Trade.

Ed is married with three children and lives in Barrington, Illinois.

GREGORY E. SAUNDERS

Gregory E. (Greg) Saunders is the Director of the Defense Standardization Program Office (DSPO). This office serves as the Secretary's Executive Agent for the Defense Standardization Program. In this capacity Greg is responsible for all facets of implementing Mil Spec Reform and for policies and procedures on Defense Standardization including the development and use of Qualified Manufacturers Lists, use of industry standards, development of performance specifications and Commercial Item Descriptions. The DSPO also facilitates greater use of commercial products and nondevelopmental items (NDI), and the use of more commercial buying practices. Greg is the vice-chair of the Defense Standardization Council.

Prior to this assignment, Greg was the Deputy Director for Acquisition Practices in the Office of the Secretary of Defense where he was responsible for many of the same issues and was one of the principal proponents of commercial and NDI acquisition. He served on two Defense Science Board Studies on Use of Commercial Components in Defense Systems, both chaired by Secretary Perry, and was responsible for DoD's implementation of their recommendations; has testified before congress on DOD's progress implementing a statutory preference for NDI; and has served on numerous study groups.

Before 1986, Mr. Saunders was a staff member of the Defense Materiel Specifications and Standards Office where he was responsible for the DoD's program to adopt and use standards produced by voluntary standards organizations and for various other aspects of standardization policy.

He is an engineering graduate of the University of Evansville in Evansville Indiana. Greg is on the Boards of Directors of ASTM and the American National Standards Institute (ANSI). He serves on the Aerospace Council of the Society of Automotive Engineers, and has chaired ANSI's Government Member Council and the Standards and Data Services Committee. He is the U.S. representative to a NATO Board and is the Department of Defense Representative on the Interagency Committee on Standards Policy.

Mr. Saunders has won numerous awards including the Vice President's Golden Hammer Award, the Department of Defense Civilian Service Award, the Joint Meritorious Unit Award, ANSI's Meritorious Service Award and industry's Equal Partner Award.

Greg lives in Herndon Virginia with his wife, two dogs and four cats. He is active in church work and enjoys furniture making, guitar playing, and auto racing.

Greg may be reached at his internet address: "Gregory_Saunders@HQ.DLA.MIL" or by telephone at (703) 767-6888.

OLIVER R. SMOOT

Oliver Smoot was elected chairman of the American National Standards Institute (ANSI) Board of Directors on December 7, 2000. He also serves as vice-president for external voluntary standards relations of the Information Technology Industry Council (ITI), a post to which he was appointed in 2000 to support ITI's activities in voluntary standards domestically and internationally.

Before being elected as chairman of the ANSI Board, Mr. Smoot served in numerous ANSI leadership posts, including service as chair of ANSI's Finance Committee, Organizational Member Council and Patent Group.

Before being elected ITI's vice-president for external voluntary standards relations, Mr. Smoot held the post of ITI's executive vice-president for 23 years. During this tenure he was responsible for ITI's internal activities including the association's technical regulatory activities and its voluntary standards activities: the National Committee for

Information Technology Standards (NCITS) and the U.S. Technical Advisory Group (TAG) to ISO/IEC JTC 1, the Joint Technical Committee 1 on Information Technology Standards of the International Organization for Standardization and the International Electrotechnical Commission.

An active member of the American Bar Association for many years, Mr. Smoot currently serves as chairman of its Technical Standardization Law Committee and has previously served as chairman of the Section on Science and Technology Law. He has also served in numerous positions with the Computer Law Association, culminating as President, and currently serves on the Executive Committee of the U.S. Policy Committee of the Association for Computing Machinery (ACM).

Mr. Smoot has served on numerous international delegations and U.S. Governmental advisory committees. He received a Juris Doctor from Georgetown University and a Bachelor of Science from the Massachusetts Institute of Technology.

JACK SNELL

Jack Snell came to NBS in 1971 after hearing then Director, Lou Branscomb describe NIST's main thing as "facilitating technical innovation for the public benefit." Snell's duties at NIST have included responsibility for energy programs, fire research and now the Building and Fire Research Laboratory. He is particularly excited about the implications of advances in science and technology for the future of construction and buildings and for reducing losses to fire and other disasters.

Dr. Snell has a BSE in Aeronautical Engineering from Princeton, and a MSE in Industrial Engineering and Operations Research and PhD in Civil Engineering from Northwestern. He is a recipient of the Commerce Department's Silver and Gold medals.

KEITH TERMATT

Mr. Keith Termaat is Exterior Technology Manager for Ford Motor Company. He standardizes and innovates technologies and migrates them to brands. Exterior systems, including visibility, are a US $4 billion commodity. Keith is active in standardization policy and governance as a Director on the ANSI Board, member of the Board Executive and Finance Committees and past-chair of the ANSI Company Member Council. He also chairs the SAE Technical Standards Board.

Mr. Termaat has held senior management positions in automotive technology development standardization, strategic planning and automotive engineering.

Mr. Termaat holds BS and MS degrees in Engineering from the University of Michigan. His upbringing in the Netherlands and the United States contributes to a well-formed world view.

JAMES A. THOMAS

James A. Thomas, president of ASTM, is a native of Philadelphia, Pennsylvania. He received his bachelor of science degree in industrial relations in 1976, and his master's degree in organization and management in 1990, both from LaSalle University.

Thomas has devoted his entire career to ASTM, where he has served in various positions since 1972. His career has been concentrated on association management and the issues facing voluntary standardization.

In 1983, Thomas was promoted to vice president of the Standards Development Division, where he was responsible for all ASTM technical committee operations, including guiding new technical committees in the early stages of their development and for representing ASTM in standards development activities with other organizations.

Thomas was appointed executive vice president of the Society in 1987. His responsibilities in that office included directing the development and implementation of operating policies, and the analysis and evaluation of operations to assess attainment of growth and financial objectives.

His appointment as president of ASTM became effective on July 1, 1992.

Thomas is a member of the Standards Engineering Society, the Council for Engineering and Scientific Society Executives, the American Society for Association Executives, and the Industry Functional Advisory Committee on Standards for Trade Policy Matters. He also serves on the Board of Directors of the American National Standards Institute.

James A. Thomas | President | ASTM
100 Barr Harbor Drive | PO Box C700 | West Conshohocken, PA 19428-2959
Phone: (610) 832-9598 | Fax: (610) 834-3650 | E-mail: jthomas@astm.org

Appendix D
Final Participants List

David Alderman
NIST
100 Bureau Drive
Mail Stop 2140
Gaithersburg, MD 20899-2140 USA
Telephone: 301/975-4019
Fax: 301/926-2884
Email: david.alderman@nist.gov

Ernest Ambler
4 Oyster Rake Court
Hilton Head Island, SC 29926 USA
Telephone: 843/689-6560
Email: aeambler1@aol.com

Alexander Astashenkov
VNIIMS
119361
46, Ozernaya
Moscow, RUSSIA
Telephone: 7/0954375577
Fax: 7/0954375666
Email: office.vniims@g23.relcom.zu

Ed Barrett
Sony
100 N. Arlington Hts. Rd.
Itasca, IL 60143 USA
Telephone: 630/773-6193
Fax: 630/773-6068
Email: ed.barrett@am.sony.com

Dan Bart
TIA
2500 Wilson Blvd.
Ste. 300
Arlington, VA 22201 USA
Telephone: 703/907-7703
Fax: 703/907-7727
Email: dbart@tia.eia.org

Ellyn Beary
NIST
100 Bureau Drive
MS 8300
Gaithersburg, MD 20899 USA
Telephone: 301/975-8307
Fax: 301/975-3845
Email: ellyn.beary@nist.gov

Matthew Bily
Ofc. for Stnds., Met. & Test.
Stefanovicova 3
Bratislava, 81005 SLOVAKIA
Telephone: 421/752491713
Fax: 421/752491050
Email: kutkova@normoff.gov.sk

Lilia Birnaz
Min. of Transport & Comm.
134 Stefan Cel Mare
Kishinev MD 2012, MOLDOVA
Telephone: 37/32251153
Email: lilia@mei.gov.md

Tyler Bjornson
Dept. of Foreign Affairs
125 Sussex Drive
Ottawa, Ontario, K1A 0G2 CANADA
Telephone: 613/995-7231
Fax: 613/943-0345
Email: tyler.bjornson@dfait-maeci.gc.ca

Reg Blake
BSI Amerca, Inc.
12110 Sunset Hills Rd.
Suite 140
Reston, VA 20190-3231 USA
Telephone: 703/464-1908
Fax: 703/437-9001
Email: reg.blake@bsiamericas.com

Howard Bloom
NIST
100 Bureau Drive
MS 8200
Gaithersburg, MD 20899-8200 USA
Telephone: 301/975-3400
Fax: 301/948-5668
Email: howard.bloom@nist.gov

Roman Borukhov
SABIT / USDOC
14th & Constitution Ave., NW
HCHB 3319
Washington, DC 20230 USA
Telephone: 202/482-0073

Laurence Bory
Natl. Soc. of Prof. Engineers
1420 King Street
Alexandria, VA 22314-2794 USA
Telephone: 703/684-2874
Fax: 703/836-4875
Email: lbory@nspe.org

Mykola Boyko
Ukrainian Sci. Rsrch. Int. of Rad.
31 Bunin Street
Odessa 65026, UKRAINE
Telephone: 38/0482249500
Fax: 38/0782224583
Email: certcent@uniirt.com.ua

Lewis Branscomb
John F. Kennedy Sch. of Govt.
Harvard Univ.
79 JF Kennedy St., L331B
Cambridge, MA 02138 USA
Telephone: 617/495-1853
Fax: 617/495-8963
Email: lewis_branscomb@harvard.edu

Maureen Breitenberg
NIST
100 Bureau Drive
Mail Stop 2100
Gaithersburg, MD 20899-2100 USA
Telephone: 301/975-4031
Fax: 301/963-2871
Email: maureen.breitenberg@nist.gov

Kim Carneiro
DEM
Matematiktorvet
307
Kgs lyngby, DK 2800 DENMARK

B. Stephen Carpenter
NIST
100 Bureau Drive
MS 1090
Gaithersburg, MD 20899-1090 USA
Telephone: 301/975-4119
Fax: 301/975-3530
Email: bcarpenter@nist.gov

Armando Mariante Carvalho
INMETRO
Rua Santa Alexandrina
416/10 andar
Rio de Janeiro RJ, 20232-261 BRAZIL
Telephone: 55/215632801
Fax: 55/215026542
Email: presi@inmetro.gov.br

Ismael Castelazo
CENAM
A.P. 1-100 Centro
Queretaro Qro 76000, MEXICO

Carlos Castro
Portuguese Inst. for Quality
R. Antonio Giao 2
2829-513
Caprica, PORTUGAL
Telephone: 351/212948105
Fax: 351/212948110
Email: ncastro@mail.ipq.pt

Shi Changyan
Natl Inst. of Metrology
18, Bei San Huan Dong Lu
Beijing, CHINA
Telephone: 86/1064218303
Fax: 86/1064218703
Email: shichy@nim.ac.cn

Sze Wey Chua
Singapore Prod. & Std. Board
1 Science Park Drive
Singapore, 118221 SINGAPORE
Telephone: 65/7729652
Fax: 65/7783798
Email: weychua@psb.gov.sg

Martin Clancy
AIChE
3 Park Ave
18th Floor
New York, NY 10016 USA
Telephone: 212/591-7988
Fax: 212/591-8895
Email: martc@aiche.org

Belinda Collins
NIST
100 Bureau Drive
Mail Stop 2100
Gaithersburg, MD 20899-2100 USA
Telephone: 301/975-4000
Fax: 301/963-2871
Email: belinda.collins@nist.gov

David Conover
Natl. Evaluation Service
5203 Leesburg Pike
Suite 600
Falls Church, VA 22041 USA
Telephone: 703/931-2187
Fax: 703/931-6505
Email: dconover@natevac.org

Lea Contier de Freitas
INMETRO
R. Santa Alexandrina, 416
Rio de Janeiro RJ, 20261-232 BRAZIL
Telephone: 55/215632816
Fax: 55/215026542
Email: caint@inmetro.gov.br

Ion Cosuleanu
Natl. Reg. Agency of Telecomm.
134 Stefan Celmare
Chisinau MD 2012, MOLDOVA
Telephone: 373/2251302
Fax: 373/2251351
Email: cosulean@mci.gov.md

Arthur Cote
NFPA International
1 Batterymarch Park
Quincy, MA 02269 USA
Telephone: 617/984-7240
Fax: 617/984-7222
Email: acote@nfpa.org

Roosevelt DaCosta
Jamaica Bureau of Standards
6 Winchester Road
Post Office Box 113
Kingston 10, JAMAICA
Telephone: 876/9293140

Craig Day
Amer. Inst. of Aero. & Astro.
1801 Alexander Bell Dr.
Suite 500
Reston, VA 20191-4344 USA
Telephone: 703/264-3849
Fax: 703/264-7551
Email: craigd@aiaa.org

Ed de Leer
Nederlands Meetinstituut
Schoemakerstraat 97
P.O. Box 654
2600 AR Delft, NETHERLANDS
Telephone: 31/152691712
Fax: 31/152612971
Email: edeleer@nmi.nl

Christine DeVaux
NIST
100 Bureau Drive
Mail Stop 2100
Gaithersburg, MD 20899-2100 USA
Telephone: 301/975-4679
Fax: 301/963-2871
Email: christine.devaux@nist.gov

Helen Delaney
Delaney Consulting
2 Kentbury Way
Bethesda, MD 20814 USA
Telephone: 301/941-8133
Fax: 301/941-8134
Email: delconsult@aol.com

Jogindar Dhillon
NIST
100 Bureau Drive
Mail Stop 2100
Gaithersburg, MD 20899-2100 USA
Telephone: 301/975-5521
Fax: 301/963-2871
Email: jogindar.dhillon@nist.gov

Mary Jo DiBernardo
NIST
100 Bureau Drive
Mail Stop 2100
Gaithersburg, MD 20899-2100 USA
Telephone: 301/975-5503
Fax: 301/963-2871
Email: maryjo.dibernardo@nist.gov

Francis Dietz
ASME International
1828 L St., NW
Ste 906
Washington, DC 20036 USA
Telephone: 202/785-3756
Fax: 202/429-9417
Email: dietzf@asme.org

John Donaldson
ANSI
1819 L St., NW
Ste. 600
Washington, DC 20036 USA
Telephone: 202/331-3602
Fax: 202/293-9287
Email: jdonalds@ansi.org

Brenda Dunbar
Dept. of Foreign Affairs
125 Sussex Drive
Ottawa, Ontario, K1A 0G2 CANADA
Telephone: 613/992-5339
Fax: 613/943-0345
Email: brenda.dunbar@dfait-maeci.gc.ca

Gene Eckhart
NEMA
1300 N. 17th Street
Suite 1847
Rosslyn, VA 22209 USA
Telephone: 703/841-3204
Fax: 703/841-3304
Email: gen_eckhart@nema.org

Chuck Ehrlich
NIST
100 Bureau Drive
Mail Stop 2150
Gaithersburg, MD 20899-2150 USA
Telephone: 301/975-4834
Fax: 301/975-5414
Email: charles.ehrlich@nist.gov

Lawrence Eicher
ISO
P.O. Box 56
Geneva, 1211 SWITZERLAND
Telephone: 41/227430217
Fax: 41/227333430
Email: forrest@iso.ch

Kevin Ennis
Natl. Brd. of Boiler & Pres. Vess.
1055 Crupper Ave.
Columbus, OH 43229 USA
Telephone: 614/888-8320
Fax: 614/847-1828
Email: kennis@nationalboard.org

Luc Erard
BNM
1, rue Gaston Bounia
Paris, 75015 France
Telephone: 33/156568860
Fax: 33/156568870
Email: luc.erard@bmn.fr

Hee Joon Eun
Korea Research Inst. of Stndrds.
P.O. Box 102 Yusong
Taejon 305-600, KOREA
Telephone: 82/428685001
Fax: 82/428685444
Email: hjeun@kriss.re.kr

Gerard Faber
OIML
11 rue Turgot
Paris, 75009 FRANCE
Telephone: 33/148781282
Email: biml@oiml.org

Bob Feghali
ANSI
11 W. 42 Street
13th Floor
Washington, DC 10036 USA
Telephone: 212/642-4906
Fax: 212/719-0971
Email: bfeghali@ansi.org

William Fitch
Omega Point Laboratories
16015 Shady Falls Road
Elmendorf, TX 78112 USA
Telephone: 210/635-8130
Fax: 210/635-8101
Email: wfitch@opl.com

Steve Freiman
NIST
100 Bureau Drive
MS 8520
Gaithersburg, MD 20899-8520 USA
Telephone: 301/975-6119
Fax: 301/975-5334
Email: stephen.freiman@nist.gov

James French
Amer. Inst. of Aero. & Astro.
1801 Alexander Bell Dr.
Reston, VA 20191-4344 USA
Telephone: 703/264-7570
Fax: 703/264-7551
Email: jimf@aiaa.org

Thomas Fritz
Armstrong World Ind.
2500 Columbia Ave.
Room 5203A
Lancaster, PA 17604 USA
Telephone: 717/396-5679
Fax: 717/396-5486
Email: twfritz@armstrong.com

Mathias Fuenfschilling
IEC
3, rue de Varembe
CH 1211 Geneva, SWITZERLAND
Telephone: 41/61-467-6111
Fax: 41/61-467-6311
Email:
mgc_mrfuenfschilling@compuserv.com

Jennifer Garner
ITI
1250 Eye Street, NW
Suite 200
Washington, DC 20005 USA
Telephone: 202/626-5737
Fax: 202/638-4922
Email: jgarner@itic.org

Katharine Gebbie
NIST
100 Bureau Drive
MS 8400
Gaithersburg, MD 20899-8400 USA
Telephone: 301/975-4201
Fax: 301/975-3038
Email: gebbie@nist.gov

Mark Gerashchenko
Ukrainian Rsrch. Inst. of Comm.
13 Solomenskaya St.
Kiev 03680, UKRAINE
Telephone: 38/0442766363
Fax: 38/0442262646

Veit Ghiladi
Daimler Chrysler AG
FTP/N 0534
D-70546 Stuttgars, GERMANY
Telephone: 49/7111792988
Fax: 49/7111793822
Email: veit.ghiladi@daimlerchrysler.com

Gordon Gillerman
Underwriters Laboratories
1850 M Street, NW
Suite 1000
Washington, DC 20036 USA
Telephone: 202/296-7840
Fax: 202/872-1576
Email: gillermang@aol.com

Aleksandre Glazov
Gosstandart of Russia
27 Rozhdestvenka
Moscow 103031, RUSSIA
Telephone: 7/0952084117
Fax: 7/0952084897
Email: vnii@cityline.ru

John Godfrey
ITI
1250 Eye St., NW
Suite 200
Washington, DC 2005 USA
Telephone: 202/626-5734
Fax: 202/638-4922
Email: jgodfrey@itic.org

Casey Grant
NFPA International
1 Batterymarch Park
Qunicy, MA 02269 USA
Telephone: 617/984-7241
Fax: 617/770-3500
Email: cgrant@nfpa.org

C. Cary Gravatt
NIST
100 Bureau Drive
MS 9710
Gaithersburg, MD 20899-9710 USA
Telephone: 202/482-4844
Fax: 202/482-6275
Email: cary.gravatt@nist.gov

Fred Grunder
Amer. Ind. Hygiene Assoc.
2700 Prosperity Ave.
Suite 250
Fairfax, VA 22031 USA
Telephone: 703/849-8888
Fax: 703/207-8558
Email: fgrunder@aiha.org

Manuel Gutierrez
ASME International
Three Park Ave.
20th Floor
New York, NY 10016 USA
Telephone: 212/591-8562
Fax: 212/592-8502
Email: gutierrezm@asme.org

Sandra Hale
NIST
100 Bureau Drive
Mail Stop 2100
Gaithersburg, MD 20899-2100 USA
Telephone: 301/975-3609

Dale Hall
NIST
100 Bureau Drive
Mail Stop 8500
Gaithersburg, MD 20899-8500 USA
Telephone: 301/975-5658
Fax: 301/975-5012
Email: dale.hall@nist.gov

Oscar Harasic
Org. of American States
1889 F St., NW
Washington, DC 20006 USA
Telephone: 202/458-3375

Web Heath
Boeing Company
Telephone: 253/657-6146

Franz Hengstberger
CSIR – Ntl. Metrology Lab.
Post Office Box 395
Pretoria 0001, SOUTH AFRICA
Telephone: 27/128414352
Fax: 27/128412131
Email: fhengstb@csir.co.za

Michael Hogan
NIST
100 Bureau Drive
MS 8901
Gaithersburg, MD 20899-8901 USA
Telephone: 301/975-2926
Email: m.hogan@nist.gov

Georg Hongler
CEN
Rue De Stassart 36
B-1050 Brussels, BELGIUM USA
Telephone: 00/3225500823
Fax: 00/3225500916
Email: georg.hangler@cenorm.be

Jeffrey Horlick
NIST
100 Bureau Drive
Mail Stop 2140
Gaithersburg, MD 20899-2140 USA
Telephone: 301/975-4020
Fax: 301/926-2884
Email: jeffrey.horlick@nist.gov

Paul Hough
Armstrong World Industries
2500 Columbia Avenue
Lancaster, PA 17604 USA
Telephone: 717/396-4195
Fax: 717/396-5486
Email: pahough@armstrong.com

Chang Hsu
Center for Measurement Stand.
321 Kuang Fu Road
Section 2
Hsinchu 30042, TAIWAN

Mark Hurwitz
ANSI
1819 L Street, NW
6th Floor
Washington, DC 20036 USA
Telephone: 202/293-8020
Fax: 202/293-9287
Email: mhurwitz@ansi.org

Kozo Iizuka
Natl Research Lab of Metrology
1-1-4 Umezono
Tsukuba 305-8563, JAPAN
Telephone: 81/298614149
Fax: 81/298614202
Email: k-iizuka@kubota.co.jp

Hidetaka Imai
Natl. Research Lab of Metrology
1-1-4 Umezono
Tsukuba, 305-8563 JAPAN
Telephone: 81/298614178
Fax: 81/298614138
Email: director@nrlm.go.jp

Barry Inglis
Natl. Measurement Lab
P.O. Box 218
Lindfield NSW, 2070 AUSTRALIA
Telephone: 61/2-9413-7460
Fax: 61/2-9413-7383
Email: barry.inglis@tip.csiro.au

Lev Issaev
VNIIMS
46, Ozernaya
119361
Moscow, RUSSIA
Telephone: 7/0954379910
Fax: 7/0954375666
Email: lev_issaev@gost.zu

Dimitriy Ivanov
SABIT / USDOC
14th & Constitution Ave., NW
HCHB 3319
Washington, DC 20230 USA
Telephone: 202/482-0073

Vitaliy Ivanytskiy
Odessa Sci. Rsrch. Inst. of Tele.
23 Bunin Street
Odessa 65026, UKRAINE
Telephone: 38/0482240006
Fax: 38/0482240006
Email: viv@oniis.odessa.ua

Krista Johnsen
NIST
100 Bureau Drive
MS 2150
Gaithersburg, MD 20899-2150 USA
Telephone: 301/975-5104
Fax: 301/975-5414
Email: krista.johnson@nist.gov

Joao Jornada
INMETRO
Rua Santa Alexandrina
416/10 andar
Rio de Janeiro, RJ 20261-232 BRAZIL
Telephone: 55/215632905
Fax: 55/215026542
Email: dimci@imetro.gov.br

Robert Kaarls
CIPM
Klaverwydenstraat 13
2381 VX
Zoeterwoude, NETHERLANDS
Telephone: 31/715802231
Fax: 31/715804777
Email: rkaarls@eurenet.nl

Ray Kammer
P.O. Box 246
Olney, MD 20830 USA

Richard Kayser
NIST
100 Bureau Drive
Mail Stop 2000
Gaithersburg, MD 20899-2000 USA
Telephone: 301/975-4500
Fax: 301/975-2183
Email: richard.kayser@nist.gov

William Kelly
Catholic Univ. of America
304 Pongborn Hall
Washington, DC 20064 USA
Telephone: 202/319-5160
Fax: 202/319-4499
Email: kellyw@cua.edu

Chang Suk Kim
Korea Research Inst. of Stndrds.
P.O. Box 102 Yusong
Taejon 305-600, KOREA
Telephone: 82/428685440
Fax: 82/428685444
Email: cskim@kriss.re.kr

Pavel Klenovsky
Czech Metrology Institute
Okruzni 31
Brno, 638 00 CZECH REPUBLIC
Telephone: 420/545222709
Fax: 420/545222728
Email: pklenovsky@cmi.cz

Peter Kneppo
Slovak Inst. of Metrology
Karloveska 63
Bratislava, 842 55 SLOVAKIA
Telephone: 421/765426208
Fax: 421/765429592
Email: kneppo@smu.gov.sk

William Koch
NIST
100 Bureau Drive
MS 8300
Gaithersburg, MD 20899-8300 USA
Telephone: 301/975-8301
Fax: 301/975-3845
Email: william.koch@nist.gov

Manfred Kochsiek
Physikalisch-Technishe Bund.
Bundesallee 100
Braunschweig, 38116 GERMANY
Telephone: 00/495315922000
Fax: 00/495315922002
Email: manfred.kochsiek@ptb.de

Sergey Komissarov
Gosstandort of Russia
9 Lenensky Prospekt
Moscow 117049, RUSSIA
Telephone: 7/0952367036
Fax: 7/0952376032
Email: info@gost.ru

Jean Kovalevsky
OCA/CERGA
Avenue Copernic
Grasse, 06130 FRANCE
Telephone: 33/493405387
Fax: 33/493405353
Email: kovalevsky@obs-azur.fr

Elena Krapivina
Min. for Comm. & Inf. Russian Fed.
7 Tverskaya St.
Moscow 103375, RUSSIA
Telephone: 7/0952016879
Fax: 7/0959230848
Email: nto1@ms.rosmail.com

Vitaly Kreyndalin
Ministry for Comm. & Info.
7 Tverskaya Street
Moscow 103375, RUSSIA
Telephone: 7/0959254487
Fax: 7/0959216037

Meretali Kurbanaliev
Turkmenstandarthary
14 Seidi Street
Ashgabat 744000, TURKMENISTAN
Telephone: 993/12511058
Fax: 993/12511058

Gary Kushnier
ANSI
1819 L Street, NW
Washington, DC 20036 USA
Telephone: 202/293-8020

Ulla Lahteenmaki
Ctr. for Metrology & Accred.
P.O. Box 239
FIN-00181 Helsinki, FINLAND
Telephone: 358/9-616-761
Fax: 358/9-616-7467
Email: ulla.lahteenmaki@mikes.fi

Krishan Lal
National Physical Laboratory
Dr. K.S. Krishnan Road
New-Delhi, 110012 INDIA
Email: Klal@csnpl.ren.nic.in

Diane Lay
NIST
100 Bureau Drive
Mail Stop 2150
Gaithersburg, MD 20899-2150 USA
Telephone: 301/975-5634
Fax: 301/926-1559

Walter G. Leight
NIST
100 Bureau Drive
Mail Stop 2100
Gaithersburg, MD 20899-2100 USA
Telephone: 301/975-4010
Fax: 301/963-2871
Email: walter.leight@nist.gov

Arnold Leitner
Bundesamt for Eich-U. Verm.
Arltgasse 35
Wien, A-1160 AUSTRIA
Telephone: 43/1-40-110
Fax: 43/1-49-20-875
Email: a.leitner@bev-eich.bv.at

Randall Lemond
USA Information Systems
1092 Laskin Rd.
Virginia Beach, VA 23451 USA
Telephone: 941/758-7051
Fax: 941/758-6011
Email: randyl@usainfo.com

Stacy Liestner
ANSI
1 W. 42 Street
13th Floor
New York, NY 10036 USA
Telephone: 212/642-4931
Fax: 212/398-0023
Email: sleistne@ansi.org

June Ling
ASME International
3 Park Avenue
New York, NY 10016 USA
Telephone: 212/591-8570
Fax: 212/591-8502
Email: lingj@asme.org

Henry Liu
TECRO
4301 Connecticut Ave., NW
Suite 420
Washington, DC 20008 USA
Telephone: 202/686-6400
Email: jghenry@netzero.net

Carmina Londono
NIST
100 Bureau Drive
Mail Stop 2100
Gaithersburg, MD 20899-2100 USA
Telephone: 301/975-2573
Fax: 301/963-2871
Email: carmina.londono@nist.gov

M. Teresa Lopez
Centro Espanol de Metrologia
C/Alfar, 2
Tres Cantos
Madrid, 28760 SPAIN
Telephone: 34/91 807 47 51
Fax: 34/91 807 48 07
Email: mtlopez@mfom.es

John Lucas
FDA
5600 Fishers Lane
Rm. 15A55
Rockville, MD 20857 USA
Telephone: 301/827-0917
Fax: 301/480-0814
Email: jlucas@oc.fda.gov

Janusz Lusztyk
Inst. for Natl. Meas. Stds.
Montreal Road
Bldg. M-36
Ottawa, ON K1A 0R6 CANADA
Telephone: 613/993-7666
Fax: 613/952-5113
Email: janusz.lusztyk@nrc.ca

Jean Francois Magana
Inter. Org. of Legal Metrology
11 rue Turgot
Paris, 75009 FRANCE
Telephone: 33/148781282
Fax: 33/142821727
Email: biml@oiml.org

Erikzhan Makulbekov
Newtech Distribution
76A Mametova Street
Almaty 480004, KAZAKHSTAN
Telephone: 7/3272508066
Fax: 7/3272508088
Email: ericma@newtech.kz

Donald Marlowe
FDA
9200 Corporate Blvd.
HFZ-100
Rockville, MD 20850 USA
Telephone: 301/827-4777
Fax: 301/827-4787
Email: dem@cdrh.fda.gov

Roger Martin
Sun Microsystems, Inc.
901 San Antonio Road
Palo Alto, CA 94303 USA
Telephone: 650/786-5406
Fax: 650/786-8250
Email: roger.martin@sun.com

Ileana Martinez
NIST
100 Bureau Drive
Mail Stop 2100
Gaithersburg, MD 20899-2100 USA
Telephone: 301/975-2766
Fax: 301/963-2871
Email: ileana.martinez@nist.gov

Robert McGuiness
National Physical Lab.
Queens Road
Teddington, TW11 0LW UNITED KINGDOM
Telephone: 020/89436282
Fax: 020/86140464
Email: bob.mcguiness@npl.co.uk

Mary McKiel
U.S. EPA
Ariel Rios Bldg.
1200 Penn. Ave., NW, MC7101
Washington, DC 20460 USA
Telephone: 202/260-3584
Fax: 202/260-6906
Email: mckiel.mary@epa.gov

William Mehuron
NIST
100 Bureau Drive
Mail Stop 8900
Gaithersburg, MD 20899-8900 USA
Telephone: 301/975-2900
Fax: 301/840-1357
Email: mehuron@nist.gov

Paul Mercer
USA Information Systems
2008 187th Ave NE
Redmond, WA 98052 USA
Telephone: 425/747-8443
Fax: 425/747-4434
Email: paulm@usainfo.com

Donald Meserlian
VOSI
264 Park Ave
N. Caldwell, NJ 07006 USA
Telephone: 973/228-2258
Fax: 973/228-0276
Email: meserlian@msn.com

Edward Mikoskl
Technology Strategy & Stands.
2500 Wilson Blvd.
Arlington, VA 22201-3834 USA
Telephone: 703/907-7518
Fax: 703/907-7501
Email: edwardm@eia.org

David Miller
American Petroleum Inst.
1220 L Street, NW
Washington, DC 20005 USA
Telephone: 202/682-8159
Fax: 202/962-4797
Email: miller@api.org

Susan Miller
Alliance for Telecomm. Ind. Sol.
1200 G Street, NW
Suite 500
Washington, DC 20005 USA
Telephone: 202/628-6380
Fax: 202/393-5481
Email: smiller@atis.org

Shahin Moinian
IAPMO R&T
20001 Walnut Drive, South
Walnut, CA 91789 USA
Telephone: 909/595-8449
Fax: 909/594-3690
Email: moinian@iapmu.org

Gianfranco Molinar
IMGC-CNR
Strada delle Cacce 73
Torino, 10135 ITALY
Telephone: 39/0113977306
Fax: 39/011346761
Email: g.molinar@imgc.to.cnr.it

Giorgio Moscati
INMETRO/CIPM
Rue Santa Alexandrina
416 Presidencia 106 Andar
Rio de Janeiro RJ, 20261-232 BRAZIL
Telephone: 55/215027002
Fax: 55/212930954
Email: moscati@inmetro.gov.br

Roy Mullinax
US Dept. of Housing & Urb. Dev.
451 7t St., SW
Ste. 318
Washington, DC 20410-3600 USA
Telephone: 202/708-0614
Email: roy_p._mullin@hud.gov

Margaret Musick
NIST
100 Bureau Drive
Mail Stop 2140
Gaithersburg, MD 20899-2140 USA
Telephone: 301/975-4042
Fax: 301/926-2884
Email: margaret.musick@nist.gov

Luis Mussio
LATV
Avda Italia 6201
Montevideo, URUGUAY
Telephone: 598/26013724
Fax: 598/26018554
Email: lmussio@latu.org.uy

Viktor Myronenko
Ukrainian Rsrch. Inst. of Comm.
13 Solomyonskaya Street
Kiev 03680, UKRAINE
Telephone: 38/0442766237
Fax: 38/0442262646
Email: n015@uniis.kiev.ua

Hector Nava
CENAM
Km 4.5 Carr. A Los Cues
El Marques, 76241 MEXICO
Telephone: 52/42155332
Fax: 52/42153903
Email: hnava@cenam.mx

Reinhold Nelissen
John Deere Construction Equip.
18600 S. John Deere Rd.
P.O. Box 538
Dubuque, IA 52005 USA

Robert Nickey
Naval Warfare Assess. Station
Measurement Science, MS20
P.O. Box 5000
Corona, CA 92878 USA
Telephone: 909/273-4371
Fax: 909/273-4279
Email: nickeyrw@corona.navy.mil

Anton Nikolaev
Somara Radio Research Inst.
217 Soviet Army Street
Samara 443011, RUSSIA
Telephone: 7/8462162164
Fax: 7/8462160759
Email: anik@soniir.samara.ru

Robert Noth
Deere & Company
One John Deere Place
Moline, IL 61265 USA
Telephone: 309/765-4072
Fax: 309/765-9860
Email: nothrobertw@johndeere.com

Raul Nunez-Brantes
Ntl. Inst. for Standardization
Matias Cousino 64 Piso 6
Santiago Centro
POB995-Santiago, CHILE
Telephone: 56/24410426
Fax: 562/4410427
Email: paa_rnb@entelchile.net

Joe O'Neil
NACLA
P.O. Box 4045
Gaithersburg, MD USA
Telephone: 301/975-8406
Email: secretariat@nacla.net

Anthony O'Neill
NFPA International
1110 N. Glebe Road
Suite 210
Arlington, VA 22201 USA
Telephone: 703/516-4346
Fax: 703/516-4350
Email: aoneill@nfpa.org

Stephen Oksala
Soc. of Cable Telecomm Eng.
140 Phillips Road
Exton, PA 19341 USA
Telephone: 610/363-6888
Fax: 610/363-5898
Email: soksala@scte.org

Akira Ono
Natl Research Lab of Metrology
1-1-4 Umezono
Tsukuba IB 305-8563, JAPAN
Telephone: 81/298614111
Fax: 81/298614007
Email: ono@nrlm.go.jp

JoAnne Overman
NIST
100 Bureau Drive
Mail Stop 2150
Gaithersburg, MD 20899-2150 USA
Telephone: 301/975-4037
Fax: 301/926-1559
Email: joanne.overman@nist.gov

Peter Pakay
National Office of Measures
Nemetvolgyi ut 37-39
P.O. Box 919
H-1124 Budapest, HUNGARY USA
Telephone: 36/13550577
Fax: 36/14585877
Email: pakay@omh.hu

Elisabeth Parker
NIST
100 Bureau Drive
Mail Stop 2100
Gaithersburg, MD 20899-2100 USA
Telephone: 301/975-3089
Fax: 301/963-2871
Email: elisabeth.parker@nist.gov

Albert Parr
NIST
100 Bureau Drive
Mail Stop 8440
Gaithersburg, MD 20899-8440 USA
Telephone: 301/975-2316
Fax: 301/869-5700
Email: albert.parr@nist.gov

Peter Pataki
Natl. Office of Measures
P.O. Box 919
Budapest, H-1124 HUNGARY
Telephone: 36/1-4585-312
Fax: 36/1-356-1098
Email: p.pataki@omh.hu

Ken Pearson
ASTM
100 Barr Harbor Drive
W. Conshohocken, PA 19428 USA
Telephone: 610/832-9672
Fax: 610/832-9666
Email: kpearson@astm.org

Yuri Petrov
Ctrl. Sci. Rsrch. Telecomm. Inst.
8 Perova Polia
Proezd 1 ZN115
Moscow 111141, RUSSIA
Telephone: 7/0953689573
Fax: 7/0953064654
Email: iovripetrov@mtu-net.ru

Menno Plantenga
NMI VSL B.V.
Schoemakerstraat 97
P.O. Box 654
Ar delft, 2600 NETHERLANDS
Telephone: 31/152691501
Fax: 31152691515
Email: tmplantenga@nmi.nl

Thomas Plevyak
Verizon Communications
2107 Wilson Blvd.
Arlington, VA 22201 USA
Telephone: 703/351-2953
Fax: 703/787-6625
Email: thomas.j.plevyak@verizon.com

Dusan Podhorsky
Ofc. for Stnds., Met. & Test.
Stefanovicova 3
Bratislava, 81005 SLOVAKIA
Telephone: 421/752491085
Fax: 421/752491050
Email: sitarova@normoff.gov.sk

Arati Prabhakar
U.S. Venture Partners
2180 San Hill Road
Suite 300
Menlo Park, CA 94025 USA
Telephone: 650/926-7749
Email: arati@arati.net

Terry Quinn
Bureau Intl des poids et Mesur
Pavillon de Breteuil
SEVRES F92212, FRANCE
Telephone: 33/145077070
Fax: 33/145348670
Email: tquinn@bipm.org

C.P. Ramani
ICBO
5360 Workman Mill Road
Whittier, CA 90601 USA
Telephone: 562/699-0543
Fax: 562/695-4694
Email: ramani@icbo.org

Russell Richards
DOD/Def. Info. Sys. Agncy.
10701 Parkridge Blvd.
Reston, VA 20191 USA
Telephone: 703/735-3552
Fax: 703/735-3257
Email: richar1r@ncr.disa.mil

Hazel Richmond
NIST
100 Bureau Drive
Mail Stop 2140
Gaithersburg, MD 20899-2140 USA
Telephone: 301/975-3024
Fax: 301/926-2884
Email: hazel.richmond@nist.gov

Kamie Roberts
NIST
100 Bureau Drive
Mail Stop 8901
Gaithersburg, MD 20899-8901 USA
Telephone: 301/975-2982
Fax: 301/948-1784
Email: kamie.roberts@nist.gov

Tatiana Rodzianko
SABIT / USDOC
14th & Constitution Ave., NW
HCHB 3319
Washington, DC 20230 USA
Telephone: 202/482-0073

Ed Roney
Motorola
1303 E. Algonquin Road
4th Floor
Schaumburg, IL 60196 USA
Telephone: 847/576-5222
Fax: 847/576-6758
Email: aer001@email.mot.com

Annette Rosenblum
American Chemical Society
1155 Sixteenth Street, NW
Washington, DC 20036 USA
Telephone: 202/872-4383
Fax: 202/872-6206
Email: a_rosenblum@acs.org

James Rountree
NIST
100 Bureau Drive
MS 2150
Gaithersburg, MD 20899-2150 USA
Telephone: 301/975-4035
Fax: 301/926-1559
Email: james.rountree@nist.gov

H.J. Roux
Roux International, Inc.
P.O. Box 1513
Lancaster, PA 17608 USA
Telephone: 717/464-5421
Fax: 717/464-5623

Angel Garcia San Roman
Centro Espanol de Metrologia
C/Alfar, 2
Tres Cantos
Madrid, 28760 SPAIN
Telephone: 34/91 807 47 01
Fax: 34/91 807 48 07
Email: agarcia@mform.es

Mary Saunders
NIST
100 Bureau Drive
Mail Stop 2100
Gaithersburg, MD 20899-2100 USA
Telephone: 301/975-2396
Fax: 301/963-2871
Email: mary.saunders@nist.gov

Greg Saunders
U.S. Department of Defense
8725 John Kingman Road
Suite 4235, J-330
Ft. Belvoir, VA 22060 USA
Telephone: 703/767-6880
Fax: 703/767-6876
Email: gregory_saunders@hq.dla.mil

Robert Scace
Klaros Corporation
19800 Lyndenwood Ave.
Beallsville, MD 20839 USA
Telephone: 301/972-8496
Fax: 301/407-2228
Email: scace@klaros.com

Margot Scheffer
ETSI
650 Route des Lescioles
Sophia Antipolis, 06921 FRANCE
Telephone: 33/492944910
Fax: 33/493654716
Email: margot.scheff@atsi.fr

Jane Schweiker
ANSI
1819 L Street, NW
Suite 600
Washington, DC 20036 USA
Telephone: 202/293-8020
Fax: 202/293-9287
Email: jschweik@ansi.org

Wolfgang Schwitz
Swiss Fed. Ofc. of Metrology
Lindenweg 50
Bern-Wabern, CH-3003 SWITZERLAND
Telephone: 41/313233201
Fax: 41/313233573
Email: wolfgang.schwitz@metas.ch

Hratch Semerjian
NIST
100 Bureau Drive
MS 8300
Gaithersburg, MD 20899-8300 USA
Telephone: 301/975-8300
Fax: 301/975-3845
Email: hratch.semerjian@nist.gov

Katsuo Seta
Ntl. Research Lab. Metrology
1-1-4 Umezono
Tsukuba
Ibaraki, 305-8563 JAPAN
Telephone: 81/298614362
Fax: 81/298614393
Email: seta@nrlm.go.jp

M.S. Shaalan
National Institute for Stand.
Tersa Street, El Ahram El-Giza
P.O. Box 136 Giza Code 12211
Cairo, EGYPT
Telephone: 20/23867451
Email: shaalan@sit.nis.sci.eg

Avinoam Shenhar
Natl. Physical Lab. of Israel
Telephone: 972/25661856

John Shoaff
U.S. EPA
401 M Street, SW
Washington, DC 20460 USA
Telephone: 202/260-1831
Fax: 202/260-6906
Email: shoaff.john@epa.gov

Farhod Shukurov
Tajiktelecom
53 Rudaki Avenue
Dushanbe 734025, TAJIKISTAN
Telephone: 992/372234444

Leschiutta Sigfrido
I.E.N.
Strada Delle Cacke, 81
Torino, 10125 ITALY

Oliver Smoot
ANSI
1250 I Street, NW
Suite 200
Washington, DC 20005 USA
Telephone: 202/626-5755
Fax: 202/638-4922
Email: osmoot@itic.org

Jack Snell
NIST
100 Bureau Drive
MS 8600
Gaithersburg, MD 20899-8600 USA
Telephone: 301/975-6850
Fax: 301/975-4032
Email: jack.snell@nist.gov

Reinaldo Ferraz Souza
Ministerio da Ciencia e Tec
Esplanada dos Ministerios
Bloco E, 3 andar
Brasilia, DF 70067-900 BRAZIL
Telephone: 55/613177805
Fax: 55/612256039
Email: rferraz@mct.gov.br

Elena Stroganova
Moscow Tech. Univ. of Comm.
8A Aviamoternaya Street
MTUCI
Moscow 111024, RUSSIA
Telephone: 7/0953624234
Fax: 7/0953624234
Email: certlab@srd.mtvci.rv

Mitsuru Tanaka
Natl Research Lab of Metrology
1-1-4 Umezono
Tsukuba, JAPAN
Telephone: 81/298-61-4059
Fax: 81/298-61-4009
Email: tanaka@nrlm.go.jp

Irina Tchernikova
Min. for Comm. & Inf. Russian Fed.
7 Tverskaya Street
Moscow 103375, RUSSIA
Telephone: 7/0952016220
Fax: 7/0959259276

Lori Tennant
Square D Company
P.O. Box 27446
Raleigh, NC 27611 USA
Telephone: 919/217-6720
Fax: 919/266-8862
Email: tennantl@squared.com

Nam Kuan Teo
Singapore Prod. & Std. Board
No 1 Science Park Drive
Singapore, 118221 SINGAPORE
Telephone: 65/7729509
Fax: 65/7736803
Email: teonk@psb.gov.sg

Keith Termaat
Ford Motor Co.
2000 Rotunda Dr.
MD 5031
Dearborn, MI 48121 USA
Telephone: 313/337-5120
Fax: 313/390-4452
Email: ktermaat@ford.com

James Thomas
ASTM
100 Barr Harbor Drive
W. Conshohocken, PA 19428 USA
Telephone: 610/832-9598
Email: jthomas@astm.org

Diane Thompson
Info. Handling Services
15 Inverness Way, E.
Englewood, CO 80112 USA
Telephone: 303/397-2564
Fax: 303/397-2797
Email: diane.thompson@ihs.com

Ambler Thompson
NIST
100 Bureau Drive
MS 2150
Gaithersburg, MD 20899-2150 USA
Telephone: 301/975-2333
Fax: 301/975-5414
Email: ambler.thompson@nist.gov

David Thompson
TIA
1300 Pennsylvania Ave., NW
Suite 350
Washington, DC 20004 USA
Telephone: 202/383-1479
Fax: 202/383-1495
Email: dthompso@tia.eia.org

Charlotta Thunander
Science Center Intl.
3600 Market St.
Suite 100
Philadelphia, PA 19104-2642 USA
Telephone: 215/823-5004
Fax: 215/823-5005
Email: cthunand@s-c-i.com

Ani Todorova
SASM-Natl. Ctr. of Metrology
21 ''6 Septemvri'' St.
Sofia 1000, BULGARIA
Telephone: 35/92722081
Fax: 35/929861707
Email: csm@techno-link.com

Margaret Tolbert
New Brunswick Laboratory
9800 S. Cass Avenue
Argonne, IL 60439 USA
Telephone: 630/252-2446
Fax: 630/252-6256
Email: margaret.tolbert@ch.doe.gov

Ellen Trager
NIST
100 Bureau Drive
Mail Stop 2150
Gaithersburg, MD 20899-2150 USA
Telephone: 301/975-4038
Fax: 301/926-1559
Email: ellen.trager@nist.gov

Cathleen Trail
NIST
100 Bureau Drive
Mail Stop 2100
Gaithersburg, MD 20899-2100 USA
Telephone: 301/975-4462
Fax: 301/963-2871
Email: cathleen.trail@nist.gov

Nataliya Triska
Ukrainian Rsrch. Inst. of Comm.
13 Solomenska Street
Kiev 03680, UKRAINE
Telephone: 38/0442765181
Fax: 38/0442496418
Email: triska@uniis.kiev.ua

Felipe Urresta
Instituto Ecautoriano de Norm.
Baquerizo Morano
454 y Av. 6 de Diciembre
Casilla 17-01-3999, Quito ECUADOR
Telephone: 59/32544885

Joaquin Valdes
INTI
L.N. Alem 1067 Piso 7
Suite 1001
Buenos Aires, ARGENTINA
Telephone: 00/541143140882
Fax: 00/541143132130
Email: jovaldes@inti.gov.ar

Mark Visbal
Security Industry Assoc.
635 Slaters Lane
Suite 110
Alexandria, VA 22314-1177 USA
Telephone: 703/683-0493
Fax: 703/683-2469
Email: mvisbal@siaonline.org

Andrew Wallard
Natl. Physical Lab
Queens Road
Teddington
Middlesex, TW11 0LW UNITED KINGDOM
Telephone: 44/02089436013
Fax: 44/02089436082
Email: andrew.wallard@npl.co.uk

Richard Weinstein
NASA Headquarters
300 E Street, SW
Code AE
Washington, DC 20024 USA
Telephone: 202/358-0538
Fax: 202/358-3296
Email: rweinste@mail.hq.nasa.gov

Robert Wible
Ntl. Conf. of States on Build.
505 Huntman Park Drive
Suite 210
Herndon, VA 20170 USA
Telephone: 703/437-0100
Fax: 703/481-3592
Email: rwible@ncsbcs.org

Trudie Williams
U.S. Department of Defense
87252 John J. Kingman Road
Suite 4235
Fort Belvoir, VA 22060 USA
Telephone: 703/767-6875
Fax: 703/767-6876
Email: trudie_williams@hq.dla.mil

George Willingmyre
GTW Associates for Microsoft
1012 Parrs Ridge Drive
Spencerville, MD 20868 USA
Telephone: 301/421-4138
Fax: 301/421-0977
Email: gtw@gtwassociates.com

Thomas Wolf
EIFS Industry Members Assoc.
3000 Corporate Center Dr.
Suite 270
Morrow, GA 30260 USA
Telephone: 770/968-7945
Fax: 770/968-5818
Email: wolfima@frontiernet.net

Michael Woodford
ARI
4301 N. Farfax Drive
Suite 425
Arlington, VA 22203 USA
Telephone: 703/524-8800
Fax: 703/524-9011
Email: jwalters@ari.org

Robert Wurzel
RDW International
2151 Jamieson Ave.
Suite 2101
Alexandria, VA 22314 USA
Telephone: 703/566-0959
Fax: 703/566-6265
Email: wurzel@home.com

Tomosaburo Yano
Min of Economy, Trade & Indust
1-3-1 Kasumigaseki
Chiyoda-ku
Tokyo, JAPAN
Telephone: 81/335019279
Fax: 81/335017851
Email: yano-tomosaburo@meti.go.jp

Sara Yerkes
NFPA International
1110 N. Glebe Road
Suite 210
Arlington, VA 22201 USA
Telephone: 703/516-4346
Fax: 703/516-4350
Email: syerkes@nfpa.org

Lyudmila Yurasasa
Min. for Comm. & Inf. Russian Fed.
7 Tverskaya Street
Moscow 103375, RUSSIA
Telephone: 7/0959242375
Fax: 7/0459216037
Email: sertifik@ptti.gov.ru

Girts Zeidenbergs
IBM Corporation
Route 100
Bldg. 2 MS# 2400
Somers, NY 10589 USA
Telephone: 914/766-2296
Fax: 914/766-2824
Email: zeidenb@us.ibm.com

Susan Zevin
NIST
100 Bureau Drive
Mail Stop 8900
Gaithersburg, MD 20899-8900 USA
Telephone: 301/975-2144
Fax: 301/840-1357
Email: susan.zevin@nist.gov

Eldar Zulfugarzade
NIST
100 Bureau Drive
Mail Stop 2100
Gaithersburg, MD 20899-2100 USA
Telephone: 301/975-4412
Fax: 301/963-2871
Email: eldar.zulfugarzade@nist.gov

Appendix E
Exhibitors

ASME International
Three Park Avenue
New York, NY 10016-5990
Tel: 212-591-7722 Fax: 212-591-7674
www.asme.org

American National Standards Institute
Headquarters: 1819 L Street, NW
Washington, DC 20036
Tel: 202-293-8020 Fax: 202-293-9287

New York Office: 11 West 42nd Street
New York, NY 10036
Tel: 212-642-4900 Fax: 212-398-0023
www.ansi.org

American Society for Testing and Materials
100 Barr Harbor Drive
est Conshohocken, PA 19428-2959
Tel: 610-832-9585 Fax: 610-832-9555
www.astm.org

American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
1791 Tullie Circle, N.E.
Atlanta, GA 30329
Tel: 404-636-8400 Fax: 404-321-5478
www.ashrae.org

Electronic Industries Alliance
2500 Wilson Boulevard
Arlington, VA 22201
Tel: 703-907-7500 Fax: 703-907-7501
www.eia.org

Gas Appliance Manufacturers Association
2107 Wilson Boulevard, Suite 600
Arlington, Virginia 22201
Tel: 703-525-7060 Fax: 703-525-6790
www.gamanet.org

Information Technology Industry Council
1250 Eye Street, N.W., Suite 200
Washington, DC 20005
Tel: 202-737-8888 Fax: 202-638-4922
www.itic.org

NFPA International
1 Batterymarch Park, P.O. Box 9101
Quincy, MA 02269-9101
Tel: 617-770-3000 Fax: 617-770-0700
www.nfpa.org

National Electrical Manufacturers Association
1300 North 17th Street, Suite 1847
Rosslyn, VA 22209
Tel: 703-841-3200 Fax: 703-841-3300
www.nema.org

Society of Automotive Engineers
Headquarters: 400 Commonwealth Drive
Warrendale, PA 15096-0001
Tel: 724-776-4841 Fax: 724-776-5760

Washington, DC Office: 1300 Eye Street, N.W. Suite 1090, Washington, DC 20005
Tel: 202-962-8691 Fax: 202-962-1618
www.sae.org

Standards Engineering Society
13340 SW 96th Ave.
Miami, FL 33176
Tel: 305-971-4798 Fax: 305-971-4799
www. ses-standards.org

Telecommunications Industry Association
Headquarters: 2500 Wilson Blvd., Suite 300
Arlington, VA 22201
Tel: 703-907-7700 Fax: 703-907-7727

Washington, DC Office: 1300 Pennsylvania Ave., Suite 350, Washington, DC 20004
Tel: 202-383-1480 Fax: 202-383-1495
www.tiaonline.org

Underwriters Laboratories
Headquarters: 333 Pfingsten Road
Northbrook, IL 60062-2096
Tel: 847-272-8800 Fax: 847-272-8129

Washington, DC, Gov't Liaison Office:
818 18th Street, N.W., Suite 230
Washington, DC 20006-3513
Tel: 202-296-7840 Fax: 202-872-1576
www.ul.com

Vent-Free Gas Products Alliance
2111 Wilson Blvd., Suite 600
Arlington, VA 22201
Tel: 703-875-8615 Fax: 703-276-8089
www.gamanet.org/consumer/ventfree/