VISITING COMMITTEE ON ADVANCED TECHNOLOGY (VCAT or Committee)
MINUTES OF THE JUNE 5TH and 6th, 2018 MEETING
GAITHERSBURG, MD

ATTENDANCE:

Visiting Committee
Members Attending
Adler, Allen
Alexander, Jay
Colwell, Rita
Fischer, George
Garvey, Michael (Mike)
Ishak, Waguih
Ku, Katharine
Prafullchandra, Hemma
Sizer, Theodore (Tod)
Wasserman, Gail

Designated Federal Officer
Shaw, Stephanie

NIST Leadership Board
Banovic, Stephen
Boehm, Jason
Brockett, Del
Chin, Joannie
Copan, Walter
Fangmeyer, Bob
Gayle, Frank
Jenkins, George
Kimball, Kevin
Lin, Eric
Olthoff, James
Porch, Susanne
Romine, Charles
Schiller, Susannah
Singerman, Phillip
Thomas, Carroll
Vaughn, Robert (Skip)
Williams, Carl
Wixon, Henry

NIST Staff
Bedner, Mary
Benkstein, Kurt
Boisvert, Ron
Boutin, Chad
Brunner, Zahraha
Butters, Rolf
Campbell, Gretchen
Cavanagh, Richard
Claussen, Monica
Cranmer, David
Dohne, Kirk
Davis, Benjamin
Eldredge, Zachary
Evans, Heather*
Fasolka, Michael
Garris, Michael
Gendron, Cheryl
Gillespie, Alison
Green, Marty
Greer, Christopher
Gundlach, David
Guo, Yuebin
Hanacek, Natasha
Hanisch, Robert
Hardis, Jonathan
Harvey, Kyle
Hendricks, Jay
Hudson, Steve
Ivy, Nahla
Jillavenkatesa, Ajit
Kaiser, Debbie
Kauffman, Leah
Kushmerick, James
Luce, Emily
Martin, Natalia
Miner, Laurel
Na, Charles
Nadal, Maria

Newton, Thomas
Ouimette, Mylene
Phillips, Margaret
Porter, Gail
Przybocki, Mark
Reidy, Kari
Rudnitsky, Robert
Semerjian, Hratch
Sokol, Annie
St. Pierre, Jim
Stieren, David
Tabassi, Elham
Taylor, Jacob
Tarlov, Michael
Teske, Michael
Thorne, Roger
Hight-Walker, Angela
Warren, James
Wavering, Albert
Witherell, Paul
Zangmeister, Rebecca

Others
Evans, Alison - Lewis- Burke
    Associates LLC
Kurose, Jim - White House
    Office of Science and
    Technology Policy
Peter, Michael* – American
    College of Radiology
Popkin, Gabriel – Science
    Magazine
Webber, Naomi – Lewis- Burke
    Associates LLC

*Participated Remotely

Tuesday, June 5, 2018

Call to Order - *Dr. Rita Colwell, VCAT Chair*

Dr. Colwell called the meeting to order at 8:31 a.m. and reviewed meeting logistics. Dr. Colwell introduced the four new members to the Committee and welcomed them. Dr. Colwell turned the meeting over to Dr. Copan.

SESSION I: NIST UPDATE

NIST Update and Agenda Review – *Dr. Walter Copan, Under Secretary of Commerce for Standards and Technology and NIST Director*

Dr. Copan gave an overview of the day's schedule and welcomed the four new members, Jay Alexander, George Fischer, Katharine Ku, and Keoki Jackson and presented a brief background for each of them. He then provided an update on NIST's safety and security culture, OneNIST, program highlights, strategic priorities, personnel changes and a brief discussion of the return on investment (ROI) initiative. Beginning with security, Dr. Copan stated that the fiscal year (FY) 2018 year-to-date numbers show that cases, including recordable and DART (days away from work-restricted duty) cases, have gone down dramatically.

Dr. Copan introduced the concept of OneNIST, an initiative he is leading to bring the organization together all working towards the NIST mission and maintaining our reputation as "industry's national lab" and highlighted a new symposium series consisting of primarily NIST speakers to that end.

Dr. Copan highlighted programmatic activities in key priority areas for NIST including quantum, bioscience, Internet of Things (IoT), and Artificial Intelligence (AI), as well as ongoing efforts in advanced manufacturing, cybersecurity and disaster resilience. Dr. Copan also highlighted the importance of working through joint institutes Joint Initiative for Metrology in Biology (JIMB) and documentary standards IoT.

Dr. Copan updated VCAT members on NIST efforts from both the Resilience program, and the Hollings Manufacturing Extension Partnership Program (MEP) in response to Hurricane Maria. Recently, a team of researchers from the Engineering Laboratory (EL) has been sent to Puerto Rico to do an assessment under the National Construction Safety Team Act on the impacts of Hurricane Maria on the islands infrastructure and response and recovery efforts in the hopes of improving future building codes and processes for responding to and recovering from similar events. As part of NIST's efforts in addressing the impact of Hurricane Maria on Puerto Rico, MEP has also played a significant role providing $6.2 million in grants to fast-track support to U.S. small businesses in disaster affected regions.

Dr. Copan highlighted steps that NIST has taken to expand and improve its visibility with its stakeholders and the broader Science and Technology community. Example efforts that Dr. Copan has been directly engaged in included the Unleashing American Innovation Symposium, Maryland Technology Transfer Summit, White House Artificial Intelligence for American Industry event, personal meetings with congressional representatives (Maryland, Colorado, and others) and numerous key hearings on Capitol Hill.

Dr. Copan introduced NIST's leading role in the nation's technology transfer programs and the ROI initiative that is part of the Science and Technology Enterprise Technology. He stated that it's important to look at best practices and to have more supportive policies and procedures available across the U.S. government. Dr. Copan invited the VCAT to engage with NIST on the technology transfer journey and help determine where significant improvement opportunities exist for engagement between industry, federal Research & Development (R&D), and academia.

With respect to the FY 2018 budget that was enacted in May, Dr. Copan stated that NIST is pleased with the outcomes. A significant amount of the FY18 budget is for the construction and renovation program that is desperately needed on both the Boulder and Gaithersburg campuses. The FY 2020 budget is currently in development and NIST is hopeful that its strategic priorities are recognized as well as the ongoing requirements for NIST's infrastructure.

The VCAT was also given a brief update on personnel changes. These included Jim Olthoff stepping in as the Acting Associate Director of Laboratory Programs, Stephen Banovic as the Acting Chief Safety Officer, and George Jenkins as the Acting Director of Office of Acquisition and Agreements Management.

Discussion:

The group discussed the following topics:
- How the VCAT can assist NIST with its Strategic Planning.
- How to maintain fundamental, standards, and measurement research.
- What work NIST is doing in autonomous and connected cars.
- Lessons learned on how to articulate the value of NIST.
- A good understanding of strategic plan and fundamental needs.

For more information, see Dr. Copan's presentation.

SESSION II: NIST AND QUANTUM SCIENCE

Introduction – *Dr. James Olthoff, Acting Associate Director for Laboratory Programs, NIST*

Dr. Olthoff gave an overview of quantum science at NIST, one of NIST's four programmatic priority areas. Dr. Olthoff's presentation highlighted NIST's world-leading capability and reputation in quantum, and the importance of measurement science to the further advancement to this field.

Areas of NIST quantum research highlighted included breakthroughs in quantum-based random number generation, Physical Measurement Laboratory's (PML) work on quantum sensors, advances in atomic clock development, and work on post quantum cryptography.

For more information, see Dr. Olthoff's presentation.

Overview of Administration Priorities for Quantum Science – *Dr. Jake Taylor, Assistant Director for Quantum Information Science, White House Office of Science and Technology Policy (OSTP)*

Dr. Taylor gave a high-level overview of the Administration's priorities for quantum science focusing on how to expand American leadership in quantum information science, which consists of four areas that he expounded upon: quantum sensing, quantum communication, quantum simulation, and quantum computation.

Dr. Taylor explained that if quantum mechanics is the fundamental theory of the universe, predictions can be made with it and quantum accurate standards can be realized. NIST and other National Metrology Institutes (NMI) are aiming to create an entire system of measurements that take advantage of quantum phenomena that enable an entirely new range of sensing modalities.

Dr. Taylor highlighted advances in quantum communication, also known as quantum networking. He explained that entanglement enables new modalities in communications such as quantum key distribution. NIST has created a random number beacon whose randomness is, in fact, guaranteed by the laws of quantum

mechanics. Post-quantum cryptography, that is secure against an attack by a hypothetical quantum computer, is a key part of what NIST is doing in the crypto space. NIST hopes to have a post-quantum cryptography system fully certified by 2025. Quantum networking also has very long-term technology goals, such as the quantum internet that will be enabled by the creation of quantum computers.

Dr. Taylor continued to explain that quantum simulations can be used to validate classical simulations important in areas where quantum mechanics play a deep role, such as chemistry, material science and physics, driving new knowledge and understanding. He also went over three types of qubits: atomic qubits, superconducting qubits, and semiconductor spins. NIST has been working in this space for a long time and have become the world leader. One of the main challenges that Dr. Taylor highlighted for long term quantum success is the development of functional and reliable quantum devices.

In closing, Dr. Taylor stated that the Administration's is developing a broad strategy for quantum information science policy will encompass workforce development, market opportunities, and public-private partnerships to gain efficiency and maintain a two-way knowledge transfer for improved R&D while keeping the economic security, the national security, and the industry's secrets. The U.S. has been, and remains, the biggest funder of quantum information science around the world with the strongest programs. This is a big scientific priority for the Nation, and one that NIST has an important role in.

Discussion:

The group discussed the following topics:
- How NIST and OSTP can work together to get the White House to understand the fiscal needs.
- Commercial implementations in reference to quantum communications.
- What the connection is between quantum science and machine learning.
- A vision/message to take to Congress that shows opportunity, work to be done, and the reliance.

For more information, see Dr. Taylor's presentation.

NIST Programs and Vision in Quantum Science – *Dr. Carl Williams, Acting Director, Physical Measurement Laboratory, NIST*

Dr. Williams gave an overview of the NIST Quantum Information Science (QIS) program, which covers: sensing and metrology, communication, simulation, and computing. He mentioned that in addition to these activities that NIST quantum engineering activities must grow.

The QIS program at NIST spans across PML, Center for Nanoscale Science and Technology, NIST Center for Neutron Research, and Communications Technology Laboratory and has its roots in a 25+ year history of involvement with quantum research. He went over the detailed aspects of the current QIS activities (quantum transduction, complex quantum systems, small quantum systems, quantum materials and solid-state qubits) and pointed to future activities in the areas of: quantum engineering, quantum metrology, quantum System of Units (SI) and quantum computing.

Dr. Williams emphasized the importance of NIST's commitment to long-term research and our unique capabilities in metrology, materials and engineering for single atom devices, engineering for ion trap quantum computing, metrology for future atomic clocks and integrated photonics as critical elements to NIST's success in this field. Dr. Williams stated that PML is strengthening efforts with Information Technology Laboratory (ITL) in quantum information theory to strengthen QuICS (Quantum Information and Computer Science) to support the needs of post-quantum crypto. This effort is being accelerated, so the metrology can be built out, whether it is used for classical applications or the quantum computer.

Dr. Williams briefly outlined the concept of a QIS consortium that would allow broad interaction between academia, industry, national laboratories and government agencies. The QIS consortium would focus on identifying gaps within the QIS ecosystem, provide a mechanism for public-private partnerships, identify grand challenges, identify key technologies and identify workforce needs.

Discussion:

The group discussed the following topics:
- The number of researchers within QIS and how many are qualified U.S. candidates.
- How to balance the advance in science and technology understanding and the challenge in engineering, measurement, and applications.
- The challenge of conveying that the rewards from these investments will take time.

For more information, see Dr. William's presentation.

Joint Quantum Institute – *Dr. Gretchen Campbell, Co-Director, Joint Quantum Institute (JQI)*

Dr. Campbell began by providing a brief history of the JQI. It was created in 2006, as an equal partner between NIST and the University of Maryland (UMD), to study coherent quantum phenomena. The JQI is growing and produces approximately 15 PhD's (Doctor of Philosophy) each year, a number that is increasing, which helps produce the next generation of quantum scientists. It is recognized that JQI is the largest quantum institute in the U.S. and is recognized as an international leader in quantum science research.

JQI researchers have published over 200 papers in 2017 and over the past 7 or 8 years there have been over 1,500 published papers, a measure of success. These papers are being cited in areas of quantum information science and quantum computing. Another measure of success was the creation of QuICS in 2014 as a joint institute of NIST and UMD with 13 principal investigators and a goal to become a leader in QuICS.

There are three main thrusts of research at JQI that are focused on many-body physics: design new kinds of quantum materials, study ions, and create engineered ultra-cold gases. Other big thrusts for JQI are quantum informational and computing and quantum measurement and control. Though the focus is on physical implementation of quantum systems, JQI is exploring the development of quantum hardware.

Dr. Campbell highlighted research results in the areas of Bose-Einstein condensate "atomtronics" circuits, simulations of the early universe, lossless photonic chips, creation of a quantum computer, and the use of neural networks to describe complex quantum systems.

In closing, Dr. Campbell stated that one reason for the strength of JQI and its success is that JQI is incredibly collaborative. Showing a plot of nodes of joint authorship on papers, she explained those working at JQI have strong collaborations. Her final thought was bringing people from different fields and getting them to talk to each other really leads to new science.

Discussion:

The group discussed the challenge of rotation sensing essentially the accuracy scales with the area enclosed.

For more information, see Dr. Campbell's presentation.

SESSION III: NIST and ARTIFICIAL INTELLIGENCE

Introduction – *Dr. James Olthoff, Acting Associate Director for Laboratory Programs, NIST*

Dr. Olthoff gave a brief introduction to the session on AI, one of four technical priority areas for NIST and a strategic priority for the Nation. Dr. Olthoff highlighted NIST's role in terms of building confidence and trust in AI

systems by developing datasets and performance metrics to train, test, and quantify AI systems; and the ways that NIST researchers were using AI on research areas across NIST's laboratory programs.

Dr. Olthoff introduced the next three speakers, Jim Kurose, Assistant Director for Artificial Intelligence, White House Office of Science and Technology Policy (OSTP); Charles Romine, Director, ITL, NIST; and James Warren, Technical Program for Materials Genomics, Materials Measurement Laboratory (MML), NIST.

For more information, see Dr. Olthoff's presentation.

Overview of Administration Priorities for Artificial Intelligence – *Dr. Jim Kurose, Assistant Director for Artificial Intelligence, White House Office of Science and Technology Policy*

Dr. Kurose gave an overview on the Administration's priorities and actions in the area of AI. AI is a scientific priority of the current Administration as demonstrated by support in the OSTP/OMB (Office of Management and Budget) R&D priorities memo, and the references to AI in the National Security Strategy and the National Defense Strategy.

The Administration recognizes the importance of AI and has prioritized resources highlighted the importance of computational resources for AI R&D, computing infrastructure, machine learning, and autonomous systems. The Administration is also focused on removing barriers to the development and utilization of AI technologies, as well as, addressing workforce issues in this space, including addressing the need for technical expertise to advance the field, as well as ensuring that the current broader workforce is prepared for the utilization of AI. Another priority for the government in this space is to improve the delivery of government services through a broader adoption of AI tools, for example the U.S. Patent Office and the National Science Foundation (NSF) are both looking at using natural language processing, finding clustering techniques to do expert identification for helping program managers find reviewers and put panels together.

Dr. Kurose reviewed the 2018 White House Summit on AI for American Industry that was held on May 10, 2018. The event had over 100 participants composed of senior government officials, top AI academics, heads of industrial research laboratories, and American business leaders. It was organized into two breakout sessions; cross-cutting issues, which focused on R&D and workforce development along with regulatory barriers and sector-specific applications, which focused on food and agriculture, energy and manufacturing, financial services, healthcare, and transportation and logistics. He continued with stating some key takeaways were support for the national AI R&D ecosystem, including stronger public-private partnerships to accelerate AI R&D; developing the American workforce to take full advantage of the AI benefits; removing barriers to AI innovation in the U.S.; and enabling high-impact, sector-specific applications in AI.

A Select Committee on AI was also appointed at the May 10th meeting. Some of the key efforts of the committee will be to advise White House on interagency AI R&D priorities, consider creation of federal partnerships with industry and academia; establish structures to improve government planning and coordination of AI R&D; and identify opportunities to leverage federal data and computational resources to support the national AI R&D ecosystem.

Lastly, Dr. Kurose mentioned the G7 countries' innovation ministers produced a statement coming out of the 2018 meeting on AI asking for the following: supporting economic growth from AI innovation, increasing trust in and adoption of AI, and promoting inclusivity in AI development and deployment.

Discussion:

The group discussed the challenge of how to make big data more available and available with the correct regulations and how to keep databanks funded and operative.

For more information, see Dr. Kurose's presentation.

NIST Programs and Vision in Artificial Intelligence – *Dr. Charles Romine, Director, Information Technology Laboratory, NIST*

Dr. Romine gave an overview of NIST' programs and priorities in AI.

For historical context, he referenced a proposal for the Dartmouth Summer Research Project on AI done in the mid '50s by McCarthy, Minsky, Rochester, and Shannon that focused on ways to solve AI. Fast forward 62 years later, Dr. Romine noted that those top technology trends are still substantially relevant to the development of AI. He also went over mainstream media coverage of AI concerning the risks and rewards of advances in this space. Dr. Romine stated that some of the defining issues of the 21st century will be dealing with data, the uses and misuses of data, and the need for interoperable anonymized data, and investment in skills and training.

Dr. Romine provided an overview of the NIST Fundamental and Applied Research and Standards for AI (FARSAI) program. In the short term this program will strengthen machine learning and artificial intelligence at NIST through AI training, the development of an AI computing platform, the creation of an AI community of interest, and an AI visiting fellows program. He mentioned that NIST is investing in licenses through Coursera for formal training for between 100 and 150 people across NIST in robust AI courses. The AI Visiting Fellows Program is an opportunity for leaders in the field, recognized leaders doing outstanding work on a national scale, to share their experience, background, understanding, and knowledge at NIST. This will achieve some of the goals to have a collaborative AI at NIST with them providing technical support in machine learning projects and capabilities.

The long-term goals of the FARSAI program will be to measure and enhance the security and trustworthiness of AI systems and machine learning and to augment capabilities in cybersecurity. This will involve foundational research, work on security of AI systems, developing a common approach, including standard problems and data sets to perform reasonable comparisons of AI systems, and the development of standards and best practices, like the work NIST is engaged in through the ISO/IEC JTC1 (International Organization for Standardization/International Electrotechnical Commission Joint Technical Committee 1).

In closing, he stated that NIST has had a long history of leading development of standards and best practices related to AI. The international community has recognized this need, and NIST must be aggressive to participate in those standards bodies.

Discussion:

The group discussed the following topics:
- The difference between AI and machine learning.
- Will mathematics enable system engineering trade to drive the sensor choice?
- Will there be training datasets and evaluation datasets in AI that might be considered as reference materials in the future?

For more information, see Dr. Romine's presentation.

NIST Application of AI: Advanced Materials – *Dr. James Warren, Technical Program Director for Materials Genomics, Material Measurement Laboratory, NIST*

Dr. Warren's presentation provided an example of one technical area where NIST has already began to apply and utilize AI and machine learning tools – NIST's efforts advanced materials development under the Materials Genome Initiative (MGI) program. The key players are NSF, the Department of Energy (DOE), and NIST. The core of MGI is about accelerating design discovery, deployment of new materials, the creation of an infrastructure to integrate experimental tools, computational tools, and digital data. Acceleration in this area will be advanced with the materials innovation infrastructure and development of a next-generation workforce.

The paradigm of the common approach to computational materials design has been around for at least 30 years and is based on the idea that multiscale modeling can be used to scale up from quantum length scales to macro scale designs. The paradigm shift of AI for advanced materials is replacing decision points in the information flow between the data inputs and models.

Dr. Warren highlighted the Center for Hierarchical Materials Design (CHiMaD), a NIST-funded center of excellence focusing on MGI approaches, based in Chicago. It is a collaboration with three entities: University of Chicago, Northwestern University, and Argonne National Laboratory. One outcome of this center of excellence is the Materials Data Facility setup by DOE.

He then went over research examples including: improved modeling for force field determination, classification of materials microscopy images, efficient phase diagram measurements, autonomous phase mapping and strain tensor tomography.

Lastly, Dr. Warren stressed that machine learning and artificial intelligence are powerful tools to enhance materials science and engineering, there are opportunities with the convergence and advances in synthetic control and additive manufacturing, and there is a need to invest in internal capabilities and expertise.

Discussion:

The group discussed the following topics:
- Using AI to fabricate and then measure, making samples on the fly using robots.
- Why metal alloys are used in machine learning for material discovery instead of polymers or dielectrics.

For more information, see Dr. Warren's presentation.

SESSION IV: UPDATE AND OVERVIEW OF RENOVATION PROJECTS

Master Plan, Building Renovations, and Major Infrastructure Repairs – *Mr. Skip Vaughn, NIST Chief Facilities Management Officer*

Mr. Vaughn began with a facilities overview and is the significant challenges and risks that we face with our degrading utilities infrastructure.

Currently there is $166 million of backlog at the Boulder campus ($132.5 million major utility infrastructure) and there is $200 million of backlog on the Gaithersburg campus ($180 million major utility infrastructure). For years NIST's ability to invest in the maintenance of its facilities has been hamstrung by chronic underfunding of maintenance and repair, highlighting that for facilities in good condition, 2 percent of current replacement value should be spent annually on repair and maintenance, but for facilities in poor condition, 4 percent should be spent annually on repair and maintenance, which equates to about $121 million annually for the NIST campuses. He noted that the President's Budget for FY 2019 and FY 2020 is $40 million.

Mr. Vaughn also gave an overview of the master site plans for Boulder and Gaithersburg and gave status reports for progress along those plans. The plans are in the final stages of approval, with final approval for publication in the fall. Multiple rounds of staff and public comments period have transpired as well as presentations with the National Capital Planning Commission and the City of Gaithersburg. General Purpose Laboratories (GPLs) all get renovated, and the whole plan is predicated on a brand-new Building 228 to provide some swing space.

Lastly, Mr. Vaughn mentioned future aspirations including, develop a 5-year plan for prioritization of projects, develop an Office of Facilities and Property Management organization to execute large-scale design and construction program, and develop a 20-year buildout plan coordinating between two campuses with two master plans.

Discussion:

The group discussed the following topics:
- Amount of funding necessary to for a 20-year buildout plan.
- Facility conditions compared to other agencies and private sector.
- The right dollar amount needed to show progression in the baseline and major maintenance repair plus the core reconstruction without disruption to the research.

For more information, see Mr. Vaughn's presentation.

SESSION V: BALDRIGE

Next Steps for Baldrige Performance Excellence Program – *Mr. Robert Fangmeyer, Director, Baldrige Performance Excellence Program, NIST*

Mr. Fangmeyer gave an overview of the Baldrige program and its three-pronged approach: establish the standard of excellence, identify role-model organizations, and foster use of the standard and share best practices of role model organizations. He noted that the Baldridge program is known for its award, but it is really an educational program with an award component. The purpose of the award is to bring attention to best practices for organizational improvement.

Mr. Fangmeyer then noted that health care organizations have been the largest portion of applications and award recipients in the last 5 to 10 years. A root cause analysis of why not as many businesses are applying as in the past, points to a lack of awareness as to what Baldrige is about and the pressure of publicly held businesses to meet quarterly performance goals that compete with the time and effort to engage in Baldridge. He highlighted the Quest and an active blog titled "Blogrige" as ways in which Baldrige reaches out to the community.

Mr. Fangmeyer lastly gave an overview of some of the new products and services that have been created to increase revenues, increase impact, and reengage with business and manufacturing. Programs he mentioned were the Baldrige Executive Fellows, the Baldrige Excellence Builder, the Baldrige Examiner Training experience, Baldrige Cybersecurity Excellence Initiative, and a proposed seventh category for Baldrige: Communities of Excellence.

Discussion:

The group discussed the following topics:
- Government support.
- How the Baldrige program helps small businesses grow.
- How to engage with top-tier U.S. corporations, the manufacturing and product sector.

For more information, see Mr. Fangmeyer's presentation.

Wednesday, June 6, 2018

Call to Order - *Dr. Rita Colwell, VCAT Chair*

Dr. Colwell called the meeting to order at 8:30 a.m. and turned it over to Dr. Phillip Singerman.

SESSION VI: ADVANCED MANUFACTURING

Introduction – *Dr. Phillip Singerman, Associate Director for Innovation and Industry Services, NIST*

Dr. Singerman began by stating that this session was organized to illustrate the OneNIST vision and its connection between selected extra mural programs with the laboratory programs. NIST works with the nation's manufacturers to invent, innovate, and create through precision measurements, advanced materials, and collaborative partnerships. Partnerships with industry and academia help to advance research and support U.S. manufacturers.

Dr. Singerman conveyed that there is a very big effort on the part of NIST to support U.S. industry. The estimated support of manufacturing in the laboratory programs is $172 million, which represents over 20 percent of the Scientific and Technical Research and Services (STRS) budget and when combined with the $155 million from MEP and Manufacturing USA, it is approximately one-third of the total non-construction budget.

He also recognized the importance of standards-setting and the way NIST interacts with the industrial community and brings benefits from its research activities for U.S. national security and economic productivity.

Lastly, Dr. Singerman introduced the next three speakers: Dr. Carroll Thomas, Director, MEP; Dr. Frank Gayle, Deputy Director, Office of Advanced Manufacturing; and Dr. Elena Messina, Group Leader, Manipulation and Mobility Systems Group, Intelligent Systems Division, EL.

For more information, see Dr. Singerman's presentation.

MEP Strategic Plan and Program Update – *Ms. Carroll Thomas, Director, Hollings Manufacturing Extension Partnership Program, NIST*

Ms. Thomas' presentation covered a briefing on small and mid-sized U.S. manufacturers, MEP strategies and priorities, connections with NIST laboratories and Manufacturing USA institutes, and new MEP initiatives.

She began by describing MEP's small and mid-sized U.S. manufacturer customers: almost 99 percent of all manufacturing firms have less than 500 employees, 75 percent of small manufacturers have 20 employees or less and of the 12.3 million employees in manufacturing, about 8.2 million are with smaller manufacturing firms. MEP works with small and mid-sized U.S. manufacturers to help them create and retain jobs, increase profits, and save time and money. Last year, MEP interacted with over 26,000 manufacturers throughout the 2,100 partners, 1,300 manufacturing experts, in over 400 locations.

Next, Ms. Thomas explained the centers work with the manufactures through: outreach, assessment, definition of proposed project and approaches for solving; negotiating, consult with company and sign project contracts with fee paid to center, project execution with center staff, partner organization, and/or third-party consultants; and follow-up after completion by center to assure customer satisfaction and explore further project opportunities. The effectiveness of the MEP program is evaluated in a two-pronged approach, center and client performance. Longitudinal studies are also conducted comparing companies that received services from MEP with companies that did not. These studies show the impact, particularly with the very small companies that

receive assistance from the MEP centers. The W.E. Upjohn Institute for Employment Research published a study that found the MEP program generated a substantial return on investment of nearly 14.5:1 for the $128 million invested by the federal government using the economic analysis REMI model.

The MEP National Network has a 5-year strategy based on four pivotal areas: empower manufacturers to embrace manufacturing technologies; leverage partnerships; promote the importance of a strong manufacturing base; and maximize the national network knowledge and experience. Examples of interactions include multicenter engagement with the EL, MATTR (MEP-Assisted Technology and Technical Resource) and MEP imbedded staff person in each of the 14 Manufacturing USA Institutes working on various projects.

Ms. Thomas also highlighted several areas of critical importance that MEP has focused on recently: supply chain cost increases, acquisition-related cybersecurity requirements (i.e. Cybersecurity Self-Assessment Handbook, NIST Handbook 162) and assisting manufacturers in adopting productivity-enhancing manufacturing technologies (e.g. AI, ML, robotics).

In closing, Dr. Thomas stated MEP centers are involved in a wide variety of activities to help build the workforce development ecosystem for manufacturing.

Discussion:

The group discussed the following topics:
- How companies become aware of MEP services.
- Third-party risks evaluation for DOD suppliers – proof points for risk issues.
- Next steps for creating MEP supply chain interlock foundation.
- Using community colleges for training programs.
- Raw material testing.
- Overlaying the Baldrige framework with the MEP program.

For more information, see Ms. Thomas' presentation.

Manufacturing USA Update – *Dr. Frank Gayle, Deputy Director, Advanced Manufacturing Office, NIST*

Dr. Gayle provided an update on the Manufacturing USA program, an interagency effort in advanced manufacturing with DOD, DOE, the National Aeronautics and Space Administration (NASA), the NSF, and several other agencies. The mission of Manufacturing USA is to connect people, ideas, and technology to solve advanced manufacturing challenges, thereby enhancing industrial competitiveness, workforce development, economic growth and strengthening national security.

Dr. Gayle explained that the Manufacturing USA institutes are shared-use facilities where people from academia, government and industry can work together. Each party plays an important role in the collaboration. Large manufacturers are essential for identifying problems and providing good support into the institutes; small and medium manufacturers are part of the supply chain and, also where a lot of innovation happen; universities are key for their research base and workforce training, and government labs play a key role because of their capabilities in advanced manufacturing technology.

Of the 14 institutes, 8 were stood up by DOD, 5 by DOE, and 1 by NIST – the National Institute for Innovation in Manufacturing Biopharmaceuticals (NIIMBL). There has been $1 billion of federal committed to the institutes matched by more than $2 billion non-federal. About two-thirds of the institute members are manufacturers. Manufacturing technology is key to the program with 273 major collaborative projects.

He then went on to explain the role of the Advanced Manufacturing National Program Office (AMNPO) at NIST: to coordinate different institute activities and policy. AMNPO coordinates monthly calls with the Institute Directors Council to share ideas, holds biannual network meetings, and provides network support consisting of online shared services for all the institutes with cross-institute teams and interagency teams. An annual report

is published for the whole network, and every three years, a strategic plan for the network is released. The NIST laboratories have been a critical part of every aspect of the institutes from the very beginning.

Dr. Gayle also recognized the international efforts to model the Manufacturing USA institutes. China is planning to have 40 Manufacturing USA-like institutes by 2025. Canada is also investing nearly $1 billion in innovation superclusters, an effort comparable to the federal investment from the U.S.

Dr. Gayle finished by stating that the program is at the crossroads with several institutes coming off their initial funding. It would be a big loss for U.S. competitiveness if funding is not forthcoming for these programs. He also mentioned that there is a need to develop metrics at the institute and program levels, focusing on U.S. national priorities.

Discussion:

The group discussed the comparative data of Manufacturing USA to the Fraunhofer model in Germany.

For more information, see Dr. Gayle's presentation.

NIST and Advanced Manufacturing – Spotlight on Robotics – *Dr. Elena Messina, Group Leader, Manipulation and Mobility Systems, Intelligent Systems Division, Engineering Laboratory, NIST*

Dr. Messina provided an overview on the collaboration between the Engineering Laboratory's Robotic Systems for Smart Manufacturing with the Manufacturing USA Advanced Robotics for Manufacturing Institute. She continued with stating that there are four different programs in EL under the smart manufacturing goal but, the one she manages is the Robotic Systems for Smart Manufacturing.

She described the current state of robotics in manufacturing. Robotics in manufacturing has been a tremendous asset to many manufacturers. Robots are seen on shop floors and are strong, fast, and repeatable. There are many benefits to using robots in manufacturing, but they also have challenges in terms of how they are deployed (e.g. up-front programming, limited ability to deal with variations, separation from humans because of size/speed/strength).

Dr. Messina explained that NIST's vision is to enable robots that are more sensing and knowledge-enabled to execute tasks with less up-front programming or expensive end-of-arm tooling. It is important that robots are able to go to where the work is rather than having the work come to them which requires safe and intelligent navigation within a factory. In the future, robots will be adaptable, agile and collaborative partners to humans. NIST is working in enabling technologies such as autonomous mobility, dexterous advanced grasping, and collaborative robot systems, among others, to make the future vision attainable.

She then explained that her program reduces risks in adopting new technologies by helping manufacturers understand what the risks are and how to reduce them, while at the same time spurring innovation. Dr. Messina highlighted NIST work on standards committees for robot and unmanned vehicle safety and performance work on defining metrics and test methods (e.g. robotic agility, sensitivity, grasp strength and exoskeleton performance). NIST has a lot of advanced capabilities for collecting data in rigorous ways that most laboratories don't have and shares this information with the rest of the world.

Next, Dr. Messina explained that underlying the Robotic Systems for Smart Manufacturing program has a special focus on the small and medium enterprises, particularly regarding the technical barriers that will affect small manufacturers. The program uses MEP to find partnering enterprises, understand their issues, and collaborate with. A joint workshop, held in October 2015, on collaborative robotics with MEP small manufacturers resulted in a publication that stressed education as a common theme. Dr. Messina also provided examples of how NIST was able to aid MEP affiliates through both the South Dakota and Ohio MEP centers.

Lastly, Dr. Messina informed the VCAT that NIST partnered with the Advanced Robotics for Manufacturing Institute (ARM). ARM is the nation's leading collaborative in robotics and workforce innovation and is structured as a public-private partnership that accelerates the advancement of transformative robotic technologies and education to increase U.S. global manufacturing competitiveness. NIST has provided input in the institute from its inception. NIST staff currently serve on ARM working groups and technical advisory committees and through ongoing contributions.

Discussion:

The group discussed the following topics:
- How does the work done at NIST and other U.S. companies compare globally?
- NIST's role in assessing what robots can do, guiding designers in terms of design rules for robotics instead of designing for people, and then building robots to do what people do.
- EL working with ITL on the convergence of the software bot and how that is leading directly into supply chain management.

For more information, see Dr. Messina's presentation.

SESSION VII: NEXT STEPS AND ADJOURN

Administrative Business

Dr. Colwell stated that the VCAT has an important job to do in the next year or two and that is to work with management to get the message out to ensure that NIST's budget is not decreased but increased. Dr. Colwell also stated that it is obvious that the science and innovation at NIST is superb and NIST has the will and the capacity to assist American industry. Finally, she announced the next meeting will be October 16-17, 2018 in Boulder, CO.

There were no public comments offered.

In closing, Dr. Copan thanked all who participated in the meeting. He reiterated that VCAT is an incredibly important partner to NIST. NIST will continue to focus on capabilities to be the world leader in metrology. This is a mandate of Dr. Copan's. It is important for NIST to be a global leader, with an investment in the U.S. innovation system that translates investment into practical application. A new subcommittee of the VCAT is in the process of being established that will focus on ROI and U.S. innovation.

Adjournment
The meeting was adjourned at 11:30 AM.
I hereby certify that to the best of my knowledge; the forgoing minutes are accurate and complete.

Stephanie Shaw, Designated Federal Officer, NIST Visiting Committee on Advanced Technology
Dr. Rita Colwell, Chair, NIST Visiting Committee on Advanced Technology