Realizing the Vision: Innovative Practices to Enhance the Capability Of the Systems Engineering Workforce

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The MITRE Corporation

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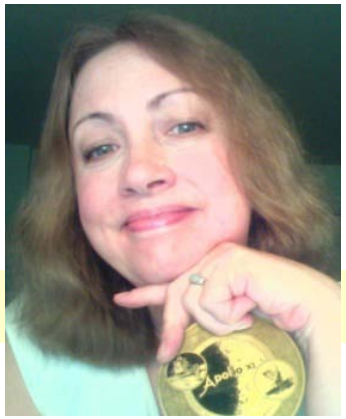

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Dr. Ziarko is the MITRE Institute's Technical Program Asst. Manager, and the Program Manager for MITRE's Federal Employee Fellowship Program, S*Eworks* Program, and on-site JHU MSSE Degree Program. The MITRE Institute is the corporate education, training, and professional development group operating under the auspices of Human Resources at The MITRE Corporation, which manages five Federally Funded Research and Development Centers (FFRDCs). She is responsible for developing and delivering programs to meet the systems engineering and technological needs of the Corporation.

Her management and education experience span more than 30 years. She has been a practicing systems/software engineer since the late 80s. Her work and academic experience includes programs and advanced research projects for Treasury/IRS, DoD (OSD, Army, Navy), NASA, EPA, GSA, Department of Interior, and the USPS. She is an Adjunct Faculty at the Johns Hopkins University Applied Physics Laboratory, Whiting School of Engineering, where she teaches systems engineering. Dr. Ziarko holds a M.S. in Information Systems and a Ph.D. in Public Administration from American University in Washington D.C. concentrating on Technology Transfer, Open Systems, and Science and Technology Policy.

Our History at MITRE

- The MITRE Corporation is a non-profit organization
  - Founded in 1958 to provide engineering and technical services to the U.S. Air Force
  - Successfully expanded these services to a broad and diverse set of sponsors within the U.S. government and internationally

MITRE Today

- Today, The MITRE Corporation manages five Federally Funded Research and Development Centers (FFRDCs)
  - Department of Defense
  - Federal Aviation Administration
  - Internal Revenue Service and Department of Veterans Affairs
  - Homeland Security (Systems Engineering Development Institute)
  - Judiciary Engineering and Modernization Center (JEMC)
- The MITRE Institute is the corporate education, training, and professional development group operating under the auspices of Human Resources at The MITRE Corporation


Is This Systems Engineering?

Is this Systems Engineering?

- The SE discipline is coming into its own
  - Yet there is no consensus on the state of the discipline
- Some consensus on SE fundamentals and standards
  - ISO15288, EIA632, CMMI, etc.
- No consensus on advanced topics
  - Enterprise Systems Engineering, System of Systems Engineering, etc.


The
BIG
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Systems Engineers Changed the World

- In the last 50 years…
  - We engineered systems that changed the world
  - We created a capable engineering workforce in the public and private sectors

- For the future…
  - We'll continue to enhance the capability of the systems engineering workforce
  - We'll continue to improve and create more innovative practices to sustain the systems engineering workforce

Public Managers and Systems Engineers

- For public managers leading major systems acquisitions and projects in the federal government, the systems engineer in the public, non-profit or private sectors is a critical asset
  - The role of the public manager and systems engineer is interwoven
  - Programmatic, technical, social and ethical considerations are involved in the decisions they make together to design and deploy systems and advanced technologies
- Many federal agencies have noted their public managers and engineers are spread too thin to effectively manage existing acquisitions

Source: Janice A. Ziarko, Mixed Contracting of Service Delivery in Federal Agencies and Bureaus: A Study in Inter-organizational Network Structure and Program Effectiveness, 2006.

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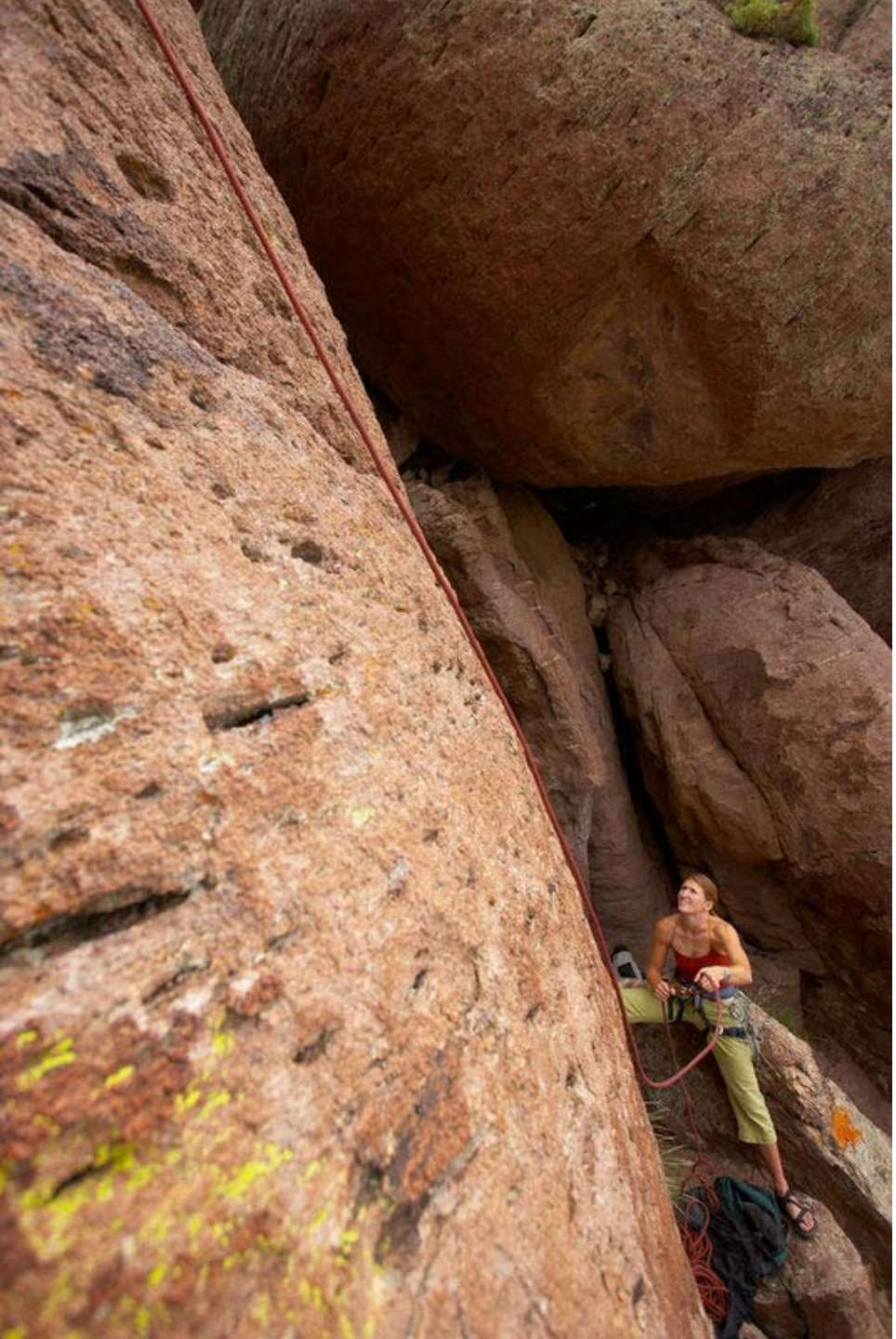
Federal SE Workforce - A Short Supply

"*The presence of experienced, domain-knowledgeable systems engineers on the development team — on both the government and the industry sides — is a critical factor in the success of any Air Force acquisition program. However, … the depth of systems engineering talent in the Air Force has declined owing to policies … that shifted the oversight of SE functions increasingly to outside contractors, as well as to the decline of in-house development planning capabilities in the Air Force.*

The result is that there are no longer enough experienced systems engineers to fill the positions in programs … particularly within the government. As acquisition programs continue to evolve from individual systems to systems of systems, this shortage will only become more acute."

Source: Air Force Study Board, Pre-Milestone A and Early-Phase Systems Engineering: A Retrospective Review and Benefits for Future Air Force Acquisition, Ch. 3, 2008.

Where Are We Headed?



Challenges for SEs On the Job

- Complex Technical Problems
- Interagency Politics
- Security Issues
- Small Budgets/Tight Schedules
- Greater Expectations
- Complex Operational Issues
- Technical Maturity
- Government Mandates
- Managing Risk/Uncertainty
- And more…

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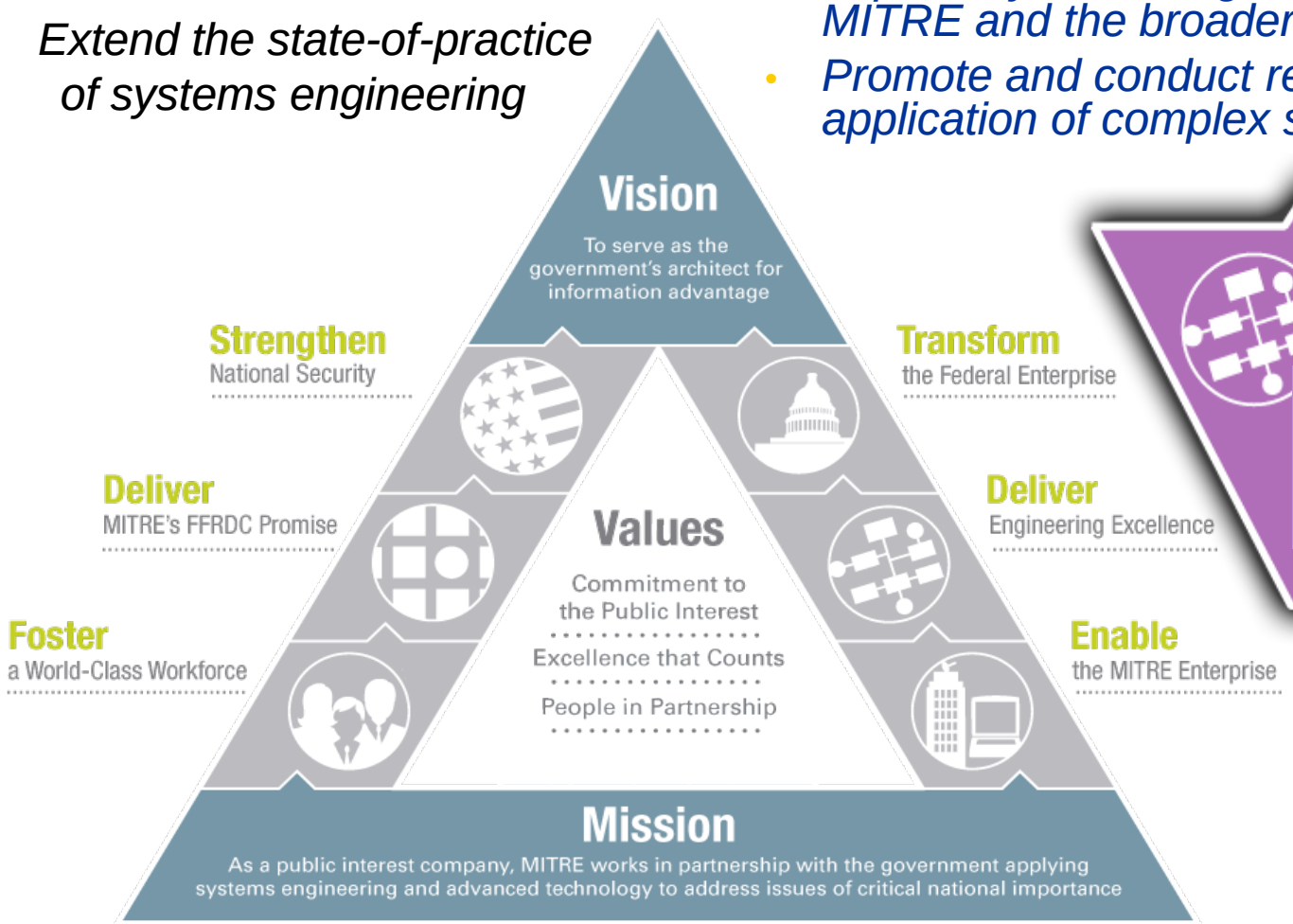
MITRE's Strategic Framework

Goal Objective

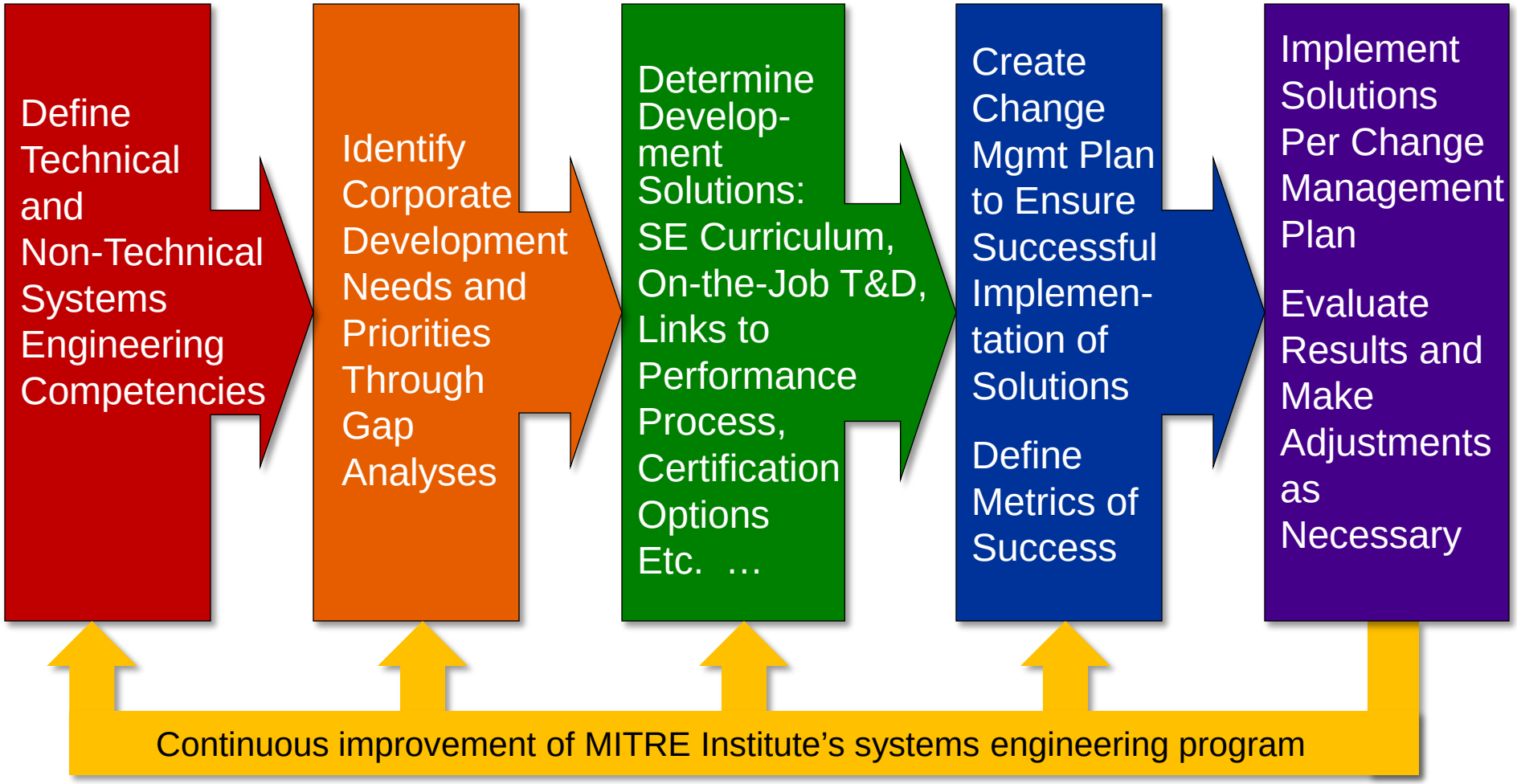
Extend the state-of-practice of systems engineering

Strategy

- *Expand systems engineering capability across MITRE and the broader community.*
- *Promote and conduct research to advance the application of complex systems engineering.*



MITRE's Strategic Approach to Enhance SE Workforce Capability




What Can We Do?
NASA

We Can Manage and Engineer Systems

- Federal government systems acquisitions are focused on acquiring suppliers to design, develop, and field government systems
- When systems were initially created, their purpose may have been focused on functions such as accounting or environmental management, or as an integration of computing and network architectures in agency environments
  - These systems may have evolved into more integrated systems interfacing with multiple other systems in today's internet and intranet rich information environment
- This mosaic of interconnected and interoperable complex systems must be engineered and managed

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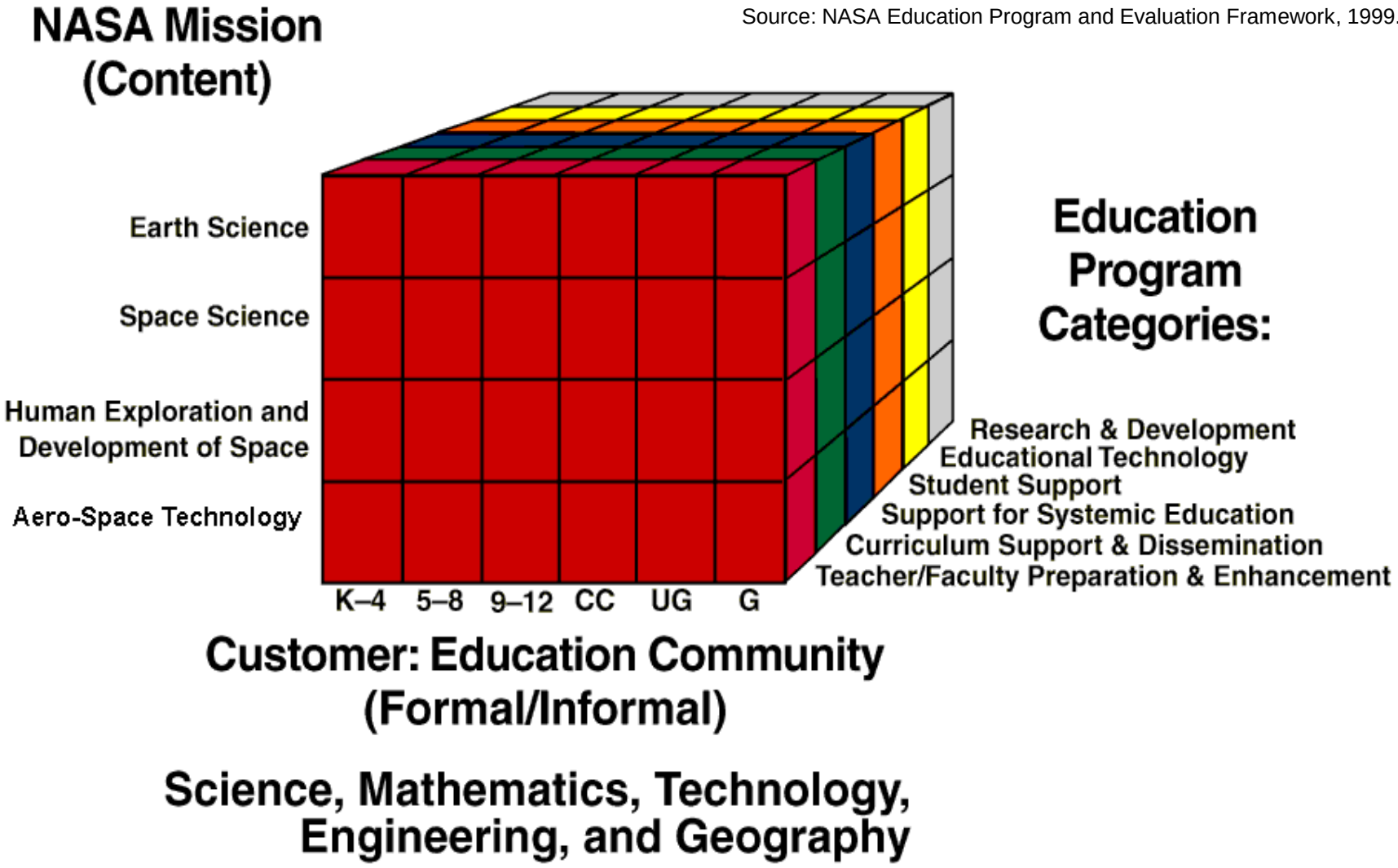
We Can Create Innovative Practices

- Federal Programs are essential to deliver assets to local, State, regional and national education efforts in science, technology, engineering and mathematics
- Hiring, Recruitment, and Development is a life long commitment which begins with School Age Children
- SE Competency Models drive Individual Development
- Education, Training and Development Solutions are instrumental for SE Workforce Development
- Partnerships and Fellowships enrich Development for SE Practitioners

NASA's Innovative Education Program

Source: NASA Education Program and Evaluation Framework, 1999.



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NASA's Education Program and Evaluation Framework

- Integrates three components
  - Content, Customer, and Program category
- Content (knowledge) based on the NASA mission is a fundamental component of any education activity
  - Strategic Enterprises: Aero-Space Technology, Human Exploration and Development of Space, Earth Science, and Space Science
- Customer is the formal and informal education community
  - Content is tailored to meet customer expectations
  - Reaches kindergarten through graduate level education communities that comprise customer segments
- Program category is the manner in which education activities are provided to the customer

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Six NASA Education Program Categories

- Teacher/Faculty Preparation and Enhancement
  - Provides NASA facilities, resources, information, and programs to advance the knowledge and skills of educators and faculty
  - Delivers professional development experiences and research opportunities for K–12 educators and higher education faculty
- Curriculum Support and Dissemination
  - Develops, utilizes, and disseminates *science, mathematics, technology, engineering, and geography* instructional materials (based on NASA's mission)
  - Supports the development of higher education curricula
  - Products are disseminated through a physical presence in each State, electronic networking resources, teacher/faculty workshops, and partnerships with organizations involved in systemic education reform

Six NASA Education Program Categories

- Support for Systemic Improvement of Education
  - Establishes partnerships to deliver assets to education efforts via collaboration with stakeholders (local, State, regional, and national)
- Student Support
  - Provides students with facilities, resources, information, experiences, programs, and research opportunities
- Educational Technology
  - Researches and develops products and services that facilitate the application of technology to enhance the educational process
  - Addresses the development of innovative learning tools, strategies, and teacher training
- Research and Development
  - Promotes collaborations with the academic community to enrich graduate education and research

We Can Recruit and Develop

- From a National perspective, recruitment and development begins in K-12 grades
  - Attract students to science, technology, engineering, and mathematics
  - Reinforce the value of public service and positive contributions of career civil servants
  - Deal with social issues (declining literacy rates, glass ceiling, etc.)
- Change begins with individuals and organizations
  - Planed activities (science fairs, field trips, children to work days)
  - Visit facilities (Wallops Island, Moffett Field, GSFC, etc.)
  - Teach children and adults in academic and professional settings
  - Development continues through adulthood
  - Continuously improve performance and capability

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We Can Utilize Competency Models

- SE Competency Models Drive Individual Development
  - Technical Acumen is a must for systems engineering
  - So are communications and team-building skills
  - Leadership and Management skills are crucial in the mix
- Corporate Assessments against Competencies Examine Staff Capability and Manager's Needs
  - Assessment of Incoming Students to Corporate T& D Program
  - Customize Their Program with an On-the-Job Project
  - Contributes to Performance and Development Plans for each Employee
- SE Competency Models Drive Curriculum Development for T&D Programs at all Levels of Proficiency

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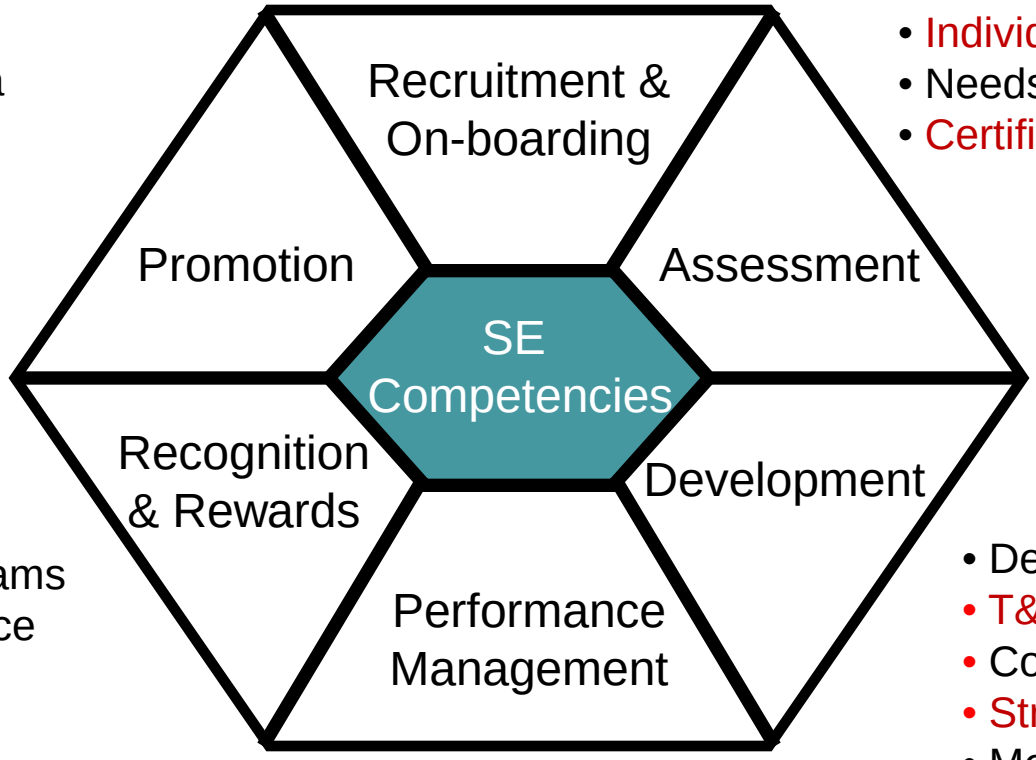
The Value of Competencies

Integration into Organizational Programs & Processes

- Job Descriptions and Sourcing
- Interviewing and Hiring
- Orientation and Assimilation

- Promotion Criteria
- Talent Reviews
- Career Planning



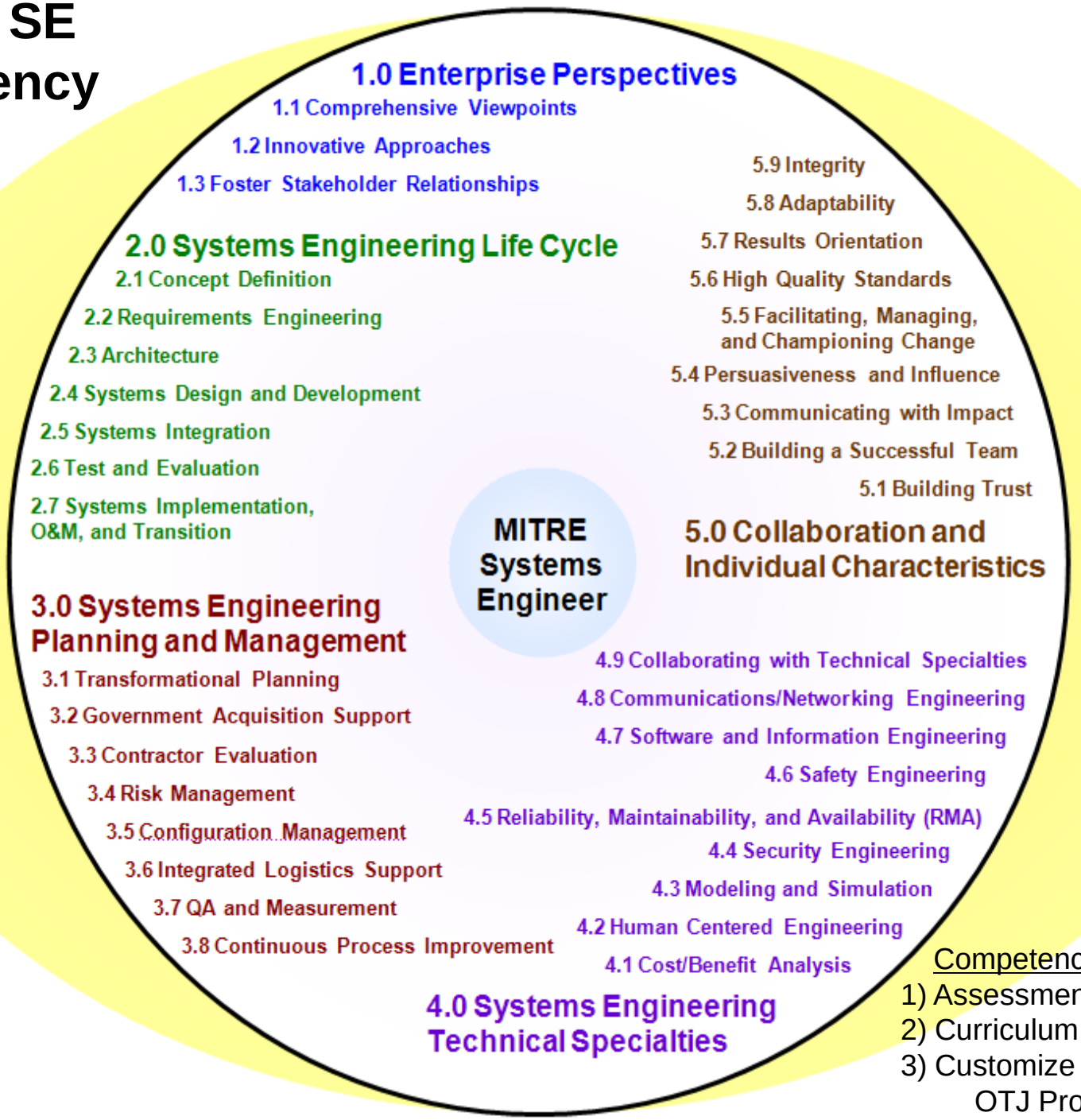
- Individual Assessment
- Needs Analysis
- Certification

- Recognition Programs
- Pay for Performance

- Degree Programs
- T&D Programs
- Conferences
- Stretch Assignments
- Mentoring Practitioners
- Job Rotation

- Performance Goals and Feedback

MITRE's SE Competency Model



Competency Model Uses

1) Assessments 2007/2008
2) Curriculum Development
3) Customize Programs with OTJ Projects

We Can Implement Development Solutions

- Education, Training and Development includes
  - Academic foundation (degrees, certificate programs)
  - Professional development (courses, on-the-job, certifications, mentoring and coaching, links to performance)
- Multiple delivery options utilizing new technologies
  - In person, on-line broadcasts(live/recorded), distance learning
- The MITRE Institute is implementing a New Program

SEworks

MITRE

Before SEworks

- The MITRE Institute had a large “Open” catalog approach
  - Continue to offer the Open Catalog for SE Development
  - Make improvements through staff and manager training surveys
  - Deliver ~ 500 course per fiscal year across a broad spectrum of systems engineering and advanced technology topics
  - Managers and staff pick and choose what they need for immediate future
- However, there was no long-term, strategic view of SE development
  - No clear articulation of what MITRE expects its SEs to know at specific proficiency levels or career levels
  - No clear expectations of what The MITRE Institute should be training SEs at specific levels of proficiency

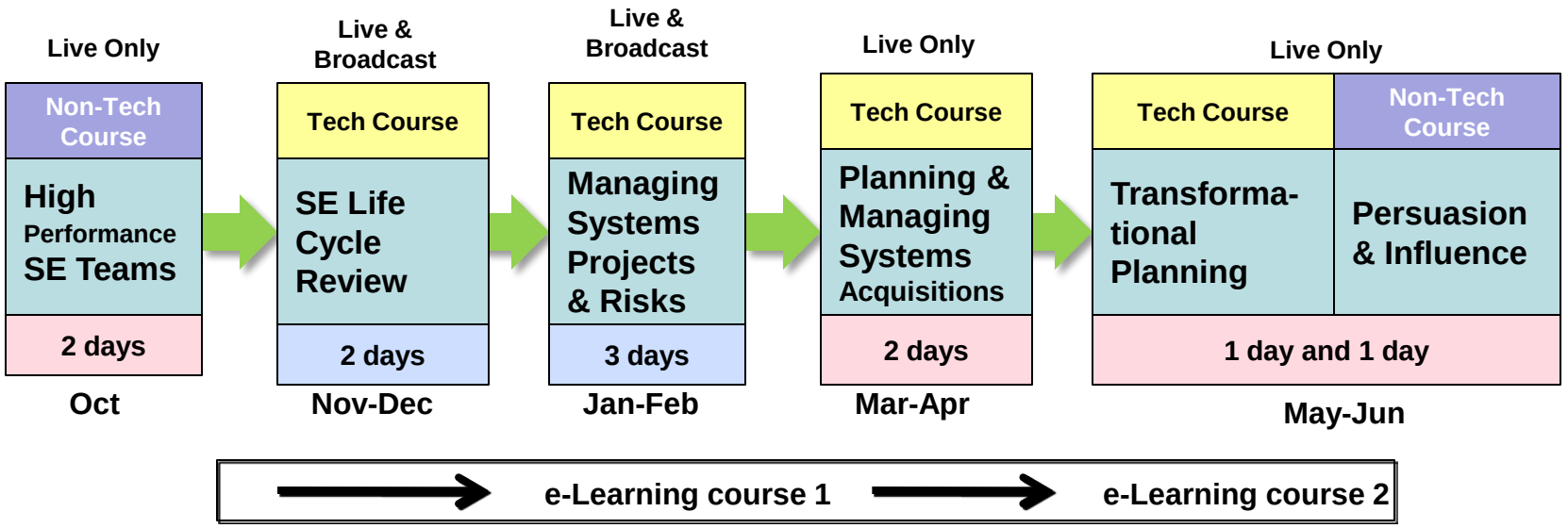
Systems Engineering at MITRE

	Technical Competencies	Non-Technical Competencies	e-Learning & Vertical Integration
SEworks 1 Foundational	**Apply Rigor to SE Lifecycle Activities & Effectively Communicate & Collaborate**		
	Competency Model–Section 2 Concept, Requirements, Architecture, Design & Development, Integration, Test & Evaluation, and System Implementation	**Competency Model–Section 5** Teams, Communicating with Impact, Adaptability, and Results Orientation	**Competency Model–Section 4** HCE, CBA, M&S, and Security Eng. **Vertical Integration** ESE, Risk
SEworks 2 Intermediate	**Lead and Manage SE Activities & Build Successful Relationships with Stakeholders**		
	Competency Model–Section 3 Transformational Planning, Acquisition Support, Contractor Evaluation, Risk, Configuration Management, Logistics, QA, and Process Improvement	**Competency Model–Section 5** Teams, Trust, Quality Standards, and Persuasiveness & Influence	**Competency Model–Section 4** MA, SwEng., Comm\Netwking & Safety **Vertical Integration** ESE, Risk
SEworks 3 Expert	**Leverage SE in the Enterprise Environment & Influence Key Stakeholders to Transform the Enterprise**		
	Competency Model–Section 1 Comprehensive Viewpoints, Innovative Approaches, and Foster Stakeholder Relationships	**Competency Model–Section 5** Persuasiveness & Influence and Change Management	**Vertical Integration** Problems & Case Studies Set in Context of Life Cycle and Lead & Manage Enterprise Simulation

All Program Levels Will Include These Components

- Programs will last approximately 8-10 months & Video broadcast
- On-the-Job Project (2-3 competencies)
- Group Work & Networking with Other Center & Site Staff
- Training & Development Database Resources
- INCOSE Certification Option

SEworks 2 Program



Technical Courses
TSE600 SE Life Cycle Review
TSE601/TSE604 Managing Systems Projects and Risks
TSE602 Planning & Managing Systems Acquisition
TSE603 Transformational Planning

Non-Technical Courses
DSE600 Building High Performance SE Teams
DSE601 Persuasion and Influence

Class size:
Groups of ~25, ~ 100 Students

Group Work and Project:

Group Work – Self-directed, virtual mentored teams; 1 hour at lunch every 2 weeks, or as directed by group
Project Work – "Give Back to Company" – group project or individual project for work program

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We Can Form Partnerships and Fellowships

- Partnerships and fellowships between public, private, and non-profit organizations create opportunities for individuals to grow and excel
- MITRE's JHU MSSE Degree Program delivers on-site and distance learning MSSE degree programs to staff in areas of concentration
  - A Memorandum of Understanding forms the partnership
  - Six cohorts have been delivered, three more are planned
- MITRE's Federal Employee Fellowship Program delivers a senior leadership experience to selected federal employees
  - A Memorandum of Agreement with a sponsoring government organization assigns the federal fellow to MITRE for 4 - 12 months
  - A collaborative organization within MITRE enables a broad experience across federal agency work programs

For the Future…

For the Future…

- More focus on national policies to grow assets in science, engineering, technology, and mathematics
- More commitment to engaging young students in science, engineering, technology and mathematics
- More rigor in defining the SE discipline and competencies to enhance workforce capability
- More systematic delivery of SE education, training, and development
- More dedication to mentoring, coaching, and teaching engineers on the job and in the classroom

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