U.S. Department of Transportation, ITS Joint Program Office (ITS JPO)
ITS Professional Capacity Building Program (ITS PCB)
4th ITS University Workshop
Washington, DC | September 22-23, 2016

Workshop Background

One of the goals of the ITS Professional Capacity Building (ITS PCB) Program is to incorporate ITS education into university curriculum and learning programs, so that recent graduates enter the field with the knowledge required of an entry-level ITS engineer. To achieve this goal, the ITS Joint Program Office (JPO) has organized a series of university workshops over the last several years. This was the fourth workshop in the series. During these workshops, the JPO shares information about ITS PCB university resources and collects feedback to develop new tools to advance ITS education. The workshop also provides opportunities to build cooperative partnerships within and outside of the ITS PCB effort.

At the first workshop (January 2012), 12 experienced professors discussed model educational programs and activities; the ITS JPO documented educational materials needed to support ITS professors. At the second workshop (September 2013), the ITS JPO engaged university professors with varying degrees of ITS teaching experience to gain feedback about the ITS instructional products the PCB Program developed, including those produced as a result of the first workshop; next steps were defined. During the third workshop (September 2014), the ITS JPO expanded the conversation to include state DOT ITS professionals. Discussions were focused on understanding the education need for an entry level ITS engineering position in the workforce and how universities can fill this requirement. Educational tools for the ITS JPO to develop were defined.

This fourth workshop redefined the current educational requirements for ITS professionals entering the workforce and reexamining the gap between ITS educational needs and the tools available. Recognizing the pace at which ITS technology is advancing, this workshop also looked at potential future needs. Professional groups presented findings from workforce development surveys; state DOT representatives involved in cutting-edge ITS initiatives gave their perspective on potential future needs; the ITS JPO and partners updated participants on available ITS resources; the group worked together to collectively identify the current (and future) educational gap, brainstorming potential solutions and assigning action items to the ITS JPO and partners.

Workshop Goals and Desired Outcomes

Workshop Goals:
- Define and understand the current – and future – education needs for an entry-level ITS position in the workforce.
- Identify and discuss existing tools from the ITS PCB Program and partners that universities can use to help build the necessary ITS capacity in students.
- Define the unmet educational needs.
- Brainstorm potential solutions to fill the unmet educational needs.
- Provide professors with a peer to peer opportunity to exchange best practices in ITS education.

Desired Outcome:
- An updated definition for the knowledge and skills that an entry-level ITS professional should have.
- A formal gap analysis, comparing the ITS educational tools available to the ITS educational need.
- Potential solutions for bridging the ITS educational gap; and action items for the ITS JPO and partners.
- Continued dialogue among participants with regards to tools, resources, and best practices.

Workshop Summary

The workshop was held over two days. During the first day, participants identified the ITS educational needs. During the second, participants examined the tools available and performed a formal gap analysis.

Ms. Michelle Noch, Program Manager for Knowledge and Technology Transfer at ITS JPO began the workshop by welcoming everyone, introducing the ITS JPO staff, and providing a brief overview of the ITS PCB Program. Workshop participants introduced themselves, shared their area of ITS expertise, how they became involved in ITS, and how they introduce their students to ITS.

Following the introduction, presentations were delivered about the ITS workforce study along with existing and emerging products and services from ITS America (ITSA), the National Operations Center for Excellence (NOCoE), and Transportation Workforce Centers (TWCs). A panel discussion followed on current needs. In the afternoon, participants heard perspectives from the State and Federal levels and a panel thus composed on emerging needs. With breakout groups, the participants defined ITS educational needs and presented their findings in a full group discussion.

The second day began with a recap of the first and then delved into the array of ITS PCB Academic resources, other ITS PCB resources, ITE-related activities, and workforce tools such as CV training materials and ITSA State Chapter Workshop Training. Lunch was followed

by an open discussion on existing and potential solutions for fulfilling the current and future ITS educational needs. Participants shared the approaches, methods, tools, and collaborations they've employed to address the educational needs identified in Day 1. After the open discussion, breakout groups identified the gaps between current educational capabilities and the workforce educational need. A brainstorming session served to propose solutions. Each group developed action items as they applied to the ITS Academic/ITS PCB Program, Academia, Professional Associations, and Other Federal Programs. Upon reconvening, action items were discussed by the group and synthesized. Next steps were briefly discussed before Day 2 adjourned.

The ITS Educational Need.

Participants defined the current, and future, ITS educational need. It was agreed that entry-level ITS professionals needed abilities and knowledge when entering the field:

Abilities:

- **Critical Thinking.**
- **Creative Problem Solving**. Traditional problem solving methods / approaches taught in STEM programs may not always yield the optimal solution. ITS professionals would benefit from a diverse background / experiences to draw from when problem solving. This may involve experiences outside the traditional STEM curriculum.
- **Clear, Concise, and Effective Communication**. Not just clear wording, but communicating the right content to the right audiences using the right mechanisms. (For example, you wouldn't tell a decision-maker about the technical details; you'd tell them about the benefits of the system).

Knowledge:

- **Emerging Technologies.** What are they, how do they work, how can they enhance an existing system, how does someone obtain them, and how does someone integrate them into an existing system.
- **Established terminology**.
- **Established frameworks, processes, & approaches for the design, operation, & maintenance of ITS systems**. About them, what they contain, how to apply them, and any specialized knowledge required to use them. [Examples: SEP (USDOT); Con-Op Standard (IEEE)]
- **ITS Standards.** What are standards, how do they work, and how does a professional use standards in design work.

Next Steps

The workshop participants concluded that there are sufficient tools and resources available with the technical material, however, raising awareness of these materials and connecting the right people with the right resources is the challenge. Additionally, there are limited resources to help students build critical abilities/skills, such as communicating with various stakeholder audiences. Action items for consideration are:

- State DOTs to connect with universities. TWCs to assist with / facilitate these connections, either through traffic managers or training directors at the DOTs.
- ITS PCB program is to bring materials to CUTC meeting at TRB in January.
- ITS PCB to create additional classroom lectures + case studies with math problems incorporated into them, like the Travel Time Case Study.
- ITS PCB to develop classroom lectures + case study for communicating with the various stakeholder groups (who to talk to, when to talk to them, what to say, and how to say it).
- ITS PCB to develop homework assignments/problem sets that are less time-intensive than case studies (to supplement the lectures).
- Professors to look for opportunities to increase interaction between students and professional practice by inviting guest speakers and getting students and researchers into the field.
  - ITSPCB to create a clearinghouse for educators to find appropriate professionals to invite to speak in class.
- ITS PCB to develop a weekly webinar series aimed at students.
- Professors to integrate presentation and communication skill-building into assignments so students learn (and gain practical experience with) how to better communicate with specialized non-technical stakeholder audiences, including: executive-level decision makers at transportation agencies; the general population; private financiers; etc.
- ITS PCB program to reinvigorate the Peer Program.
- ITS America to explore the possibility for joint student chapters of several organizations (ITE, ITSA, ASCE, WTS) to maximize exposure through overlapping interests.
- ITS America to create a "shark tank" competition with a real problem from a State DOT for ITS America chapter students to solve. Put funding behind it for deployment and offer this as award, as well as access to resources, mentoring, and visibility. Along with this concept, there will be resources and materials to help the ITS America students build effective pitches, communicating the right material to the right parties.
- ITS PCB Program to plan more T2 activities for existing products as well as spread the word through CUTC meetings, existing email blasts, and work with universities and TWCs to find best channel for building professional capacity among students.
- ITS PCB Program will create an archived webinar from workshop slides and videos, to be bookmarked and publicly available.

Participants

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Workshop Notes

Table of Contents

Workshop Day 1

Introduction

Presentation slides available here https://connectdot.connectsolutions.com/itspcbunivws_d1_1/*.*
Agenda available here https://connectdot.connectsolutions.com/itspcbunivws_agenda/

Carlos Alban of ITS America began by providing logistical and building information.

Michelle Noch, Program Manager for Knowledge and Technology Transfer at ITS JPO, opened the meeting, welcomed participants, and thanked them for dedicating their time. Enabling legislation states that the Secretary shall ensure a technically proficient ITS workforce. The ITS JPO is dedicated to research and the connected vehicle program. The Office of the Assistant Secretary for Research and Technology (OST-R) and FHWA are very supportive of the ITS PCB Program, which continues to reach more people each year. Michelle introduced the ITS JPO staff who were not in attendance: Kenneth Leonard—ITS JPO Director, Egan Smith—ITS PCB Managing Director, and Kevin Gay—Policy & Technology Transfer Team Lead. She then introduced the ITS PCB support team: Andy Berthaume (Volpe), Kathy Frankle (CITE), David Jackson (Volpe – online), Cheryl Lowrance (Noblis), and Jaime Young (Volpe). She distributed and explained a handout of the ITS JPO Organizational Chart.

This fourth workshop in the series (initiated in 2012) brought the ITS JPO together with five professional organizations/partner agencies, 16 university professors and three state DOT ITS professionals to continue the discussion on how to Integrate ITS into the university curriculum. The workshop focused on understanding the educational needs for an entry level ITS engineering position, current and future, and how universities can fill this requirement. The ITS JPO updated the participants on available ITS resources and discussed ideas for the ITS JPO to pursue for continuing to move ITS education forward.

Andy Berthaume of the Volpe Center began his introduction with the ground rules: **O**penness, **A**ctive Participation, **R**esponsibility, and **S**hare the Conversation (OARS), then briefly went over the agenda for the two days. Andy reviewed the workshop goals and desired outcomes.

Workshop Objectives and Desired Outcomes

The ITS Academic Initiative is part of the ITS PCB Program. The main goal of the ITS Academic Initiative is to incorporate ITS education into university curriculum and learning programs in a way that aligns with current and emerging needs in the workforce. The **objectives of this workshop** are to:

Figure 1: Clark Martin of the Transportation Workforce Center (front left), Cheryl Lowrance of Noblis (front right), Tyler Polling of Booz Allen Hamilton, (middle right), Xiaopeng (Shaw) Li of USF (back right). Source: Volpe Center

- Define and understand the current – and future – education needs for an entry-level ITS position in the workforce.
- Identify and discuss existing tools from the ITS PCB Program and partners that universities can use to help build the necessary ITS capacity in students
- Provide professors with a peer-to-peer opportunity to exchange best practices in ITS education.
- Define the unmet educational needs.
- Brainstorm potential solutions from the ITS PCB Program and partners to fill the unmet educational needs.

The desired outcomes of this workshop include: a set of actions for the ITS JPO and partners (including universities, professional societies, and state/county DOTs) that will help build professional capacity in students (thereby preparing future engineers for a career in ITS); and continued dialogue between participants regarding tools, resources, and best practices in ITS education.

Action items from previous workshops that the ITS PCB Program agreed to **consider** include:
1. Offer funding for undergraduate research.
2. Develop an RFP to the National Science Foundation (NSF) to develop ITS curriculum.
3. Develop an RFP for a university to develop an ITS curriculum.
4. Develop multidisciplinary program among universities to create a 5-year degree that includes an ITS specialization certificate, by working with one university such as at North Carolina State University.
5. Create a video highlighting ITS as a career.
6. Develop a TED talk on ITS.
7. Brand ITS, so it is a recognizable profession to all.
8. Define the term "ITS Engineer."
9. Develop an ITS design competition for undergraduate students with ITS America or ITE.
10. Develop core ITS competencies with ITS America or ITE.
11. Develop an on-line CITE semester course that fits with the ePrimer format. Consider a 2 semester course and break it into modules, similar to the ITS ePrimer.
12. Develop one or two additional case studies.
13. Develop material for community college teaching, like TMC operators or ITS field equipment technicians.
14. Send an e-mail to the 250 ABET universities outlining the ITS PCB resources on the PCB website such as CITE courses, ITS e-Primer, case studies, etc., available for use in classrooms.
15. Request that TRB and CITE include information on the availability of ITS resources on the PCB program website and within their newsletter.
16. Host a University Partners Workshop in 2015 (and in subsequent years).
17. Circulate the survey report that Clark Martin has developed to all participants.

From the previous workshop, participants agreed to **consider** the following actions:
1. Distribute the Google drive invitation to all participants.
2. Join the Google group.
3. Add ITS material to the Google drive, including data sets.
4. Create a group for professors teaching transportation within the LinkedIn professional network.
5. Invite dynamic ITS professionals to speak at undergraduate student orientations and ASCE/ITE student chapter meetings to highlight careers in ITS.
6. Pilot any additional case studies that are developed.

Introduction of Participants

Participants introduced themselves and answered the following questions:
*   What university and/or agency do you represent?
*   (For professors) What are your teaching/research interests?
*   (For practitioners) What type of ITS projects are you involved in? What is your ITS role in those projects?
*   What do you hope to get from this workshop?

Participants responded using the polling features in the Adobe Connect web room and verbally as a group. Responses included the following:

What are your ITS interests?
*   Applied statistics and modeling as it relates to transportation
*   Big data to do "smart" things
*   Deploying ITS, particularly using Pittsburgh/Pennsylvania as a test bed
*   Cybersecurity issues as it relates to AV/CV

- Work in emergency response, signal timing, etc.
- About ready to release statewide TSMO plan
- Conduct workshops, provide professional development to state and local staff, technical assistance opportunities, etc.
- Teach traffic operations, traffic control, ITS, safety
- Smart cities/Smart Communities
- Traffic operations, emergency evacuation and disaster response, integrating emerging technology into undergraduate class
- Resolving infrastructure and ITS, study emerging technologies, drones, etc. and how they will impact the transportation professions; how are workforce needs changing and how can we train properly?
- Travel time reliability and congestions
- AV penetration and impacts on mobility
- ITS, TSMO, signal control, performance measurement, AV, CV

What are you involved in?
- Designed intro course as exposure course to non-civil engineering students (systems engineers, robotics, etc.)
- How to market ITS PCB products to the right people
- Teach classes in public transportation and traffic flow theory; trying to incorporate ITS subjects into these courses
- Hoping to get a sense of what aspects of ITS we should be emphasizing to make students more marketable
- Transportation finance; transportation and the environment; how will changing technical innovations impact land use and urban issues?
- Teach databases for transportation professionals, research on how CV can support infrastructure
- Research in big data applications in traffic operations and management, public transportation, shared mobility, data sources to determine travel behavior
- Teach intro to transportation planning that exposes undergrads to ITS, transportation modeling, and simulation of infrastructure and signals to grad students
- Established new FHWA Center for Workforce Development
- Starting Strategic Workforce Initiative to look at operations, safety, planning, environment and understand educational needs at technical schools, community colleges, and university levels
- Research in ITS, CV, AV, interdependent infrastructure systems, AV control, reliability, disaster response and transportation, traffic flow theory
- Will teach ITS course and interested in innovative ways of teaching this subject using a variety of new tools and methods
- Started ITS course in 2003
- Developing new curriculum in ITS, will include CV material
- Involved in TWC strategic initiative

What do you hope to get from this workshop?
- Want to hear what states need and what can help universities
- See nexus between operations and security as highly important
- Desire to see what others are teaching, what relevant applications are, and what is relevant to county staff as they are making policy and investment decisions
- What are emerging impacts we can evaluate mobility- and safety-wise?
- How is readiness of state and local agencies for emerging technology and disaster response? How is readiness of infrastructure? How can they take the lead more than just monitoring?
- Looking to share resources with practitioners
- How best to train the non-university-educated workforce that will be an important part of ITS field technology?
- What strategies can we come up with in terms of TSMO in education and the roles outside of civil engineering?
- How can ITS PCB program help you integrate ITS, AV, CV into your curriculum?

- What partnerships can be initiated or expanded?
- How can we better coordinate with TWCs?

Icebreaker Exercise

An informal icebreaker exercise was used to help spark ITS conversations and to encourage active breakout group discussions. The exercise asked each group targeted questions to help identify the ITS educational need.

Icebreaker questions for engineers included:
- What does an entry-level engineer need to know about ITS when entering the field? (multiple choice)

Icebreaker questions for educators included:
- What are the greatest challenges in ITS education? (multiple choice)
- What other challenges do you face in ITS education? (open-response question)

Icebreaker questions for all participants included:
- What tools from the ITS JPO have you used to educate yourself and/or teach others about ITS? (multiple choice & ability to expand on response)
- What would be the greatest outcome of this workshop?
- Highlight something you would like to share with the group regarding ITS education

Participants were then asked to identify the core student needs in ITS education. Educators and engineers were queried separately, and came up with the following as essential for students to learn:
- Concrete examples of how technology actually works, with real data, rather than high-level theory
- Real-world experience such as internship, co-op, or research with hands-on application
- Understanding of procurement
- Understanding of standards
- Multidisciplinary awareness
- Knowledge of all phases of process—business development, planning, oversight
- Soft skills and communication
- Pilot test in real world and field experience—get researchers out of the lab and into the workplace

Icebreaker Discussion

The Icebreaker resulted in an open discussion that helped better define the current issues focused on finding competent ITS engineers. DOTs indicated that they have difficulty with young professionals getting grabbed by private sector where pay is 2-3 times higher. One DOT representative commented that technology in transportation is sometimes viewed as less exciting as applying technology elsewhere; the commenter observed that millennials want to improve/change society, and are more interested in "flashy" applications of technology that are "trendy" and claim to be able to change the world – and not just work at a state DOT. Therefore, the most competent technology folks often are drawn to other fields outside transportation. Another DOT representative commented that students need to get exposure to working in state DOTs and need to get integrated into the system and exposed to ITS. Then these students may prove to be a good fit and not go to the private sector.

The group agreed that entry-level ITS professionals should have the following before entering the field:
- Exposure course or channel for students to know about ITS and have enough knowledge to be able to explore further
- Undergraduate level needs high-level without getting "into the weeds"
- Graduate level needs details
- How ITS can relate to their discipline, interest area, or course of study, be it civil engineering or otherwise
- Need to express and demonstrate economic benefits of ITS rather than just costs and theoretical benefits

Educators concluded they needed:

- A better understanding of a millennial's career path as an ITS engineer, highlighting the details and dynamics that exist along that career path (i.e., How and in what way is this career path multifaceted and multidisciplinary? What are the knowledge requirements and expectations along each step of this career path?

Defining the Current ITS Need

Many recent efforts have been made to define the current ITS knowledge and skill requirements in the field, and to identify any deficiencies that ITS field staff may have. These efforts are being led by a number of professional societies and working group within ITS, including: ITS America, Transportation Workforce Centers (TWCs), and the National Operations Center of Excellence (NOCoE). The presentations below were delivered to help define what an entry-level ITS engineer currently needs (regarding knowledge, skills, and experience) as they enter the field.

ITS America - State Chapter Training Program / ITS Workforce Study

Carlos Alban, ITS America, Technical Programs Specialist

Anthony Shaw, ITS America

Presentation slides on ITS America activities are available here https://connectdot.connectsolutions.com/itspcbunivws_d1_2/

Presentation slides on ITS Workforce Study are available here https://connectdot.connectsolutions.com/itspcbunivws_d1_3/

Carlos Alban and Anthony Shaw (ITS America) delivered a presentation detailing recent ITS America (ITSA) activities and efforts. ITSA has been working on a number of initiatives to define the ITS needs around the nation. The two main topics were the Workforce Study and the State Chapter Training Program. Carlos provided an overview of the ITSA training efforts that covered the following:

- Background
- History of Workshops
- Benefits of Training
- Future of Program
- How to Get Involved

The goals of the **ITS America Workforce Study** was to (1) create a conceptual framework for understanding the ITS workforce, (2) create a Framework Table – compilation and classification of relevant KSAs and tasks, and (3) conduct industry interviews and analyze subsequent findings. Industry interviews were taken from a variety of position types and had several key findings including:

- ITS is interdisciplinary in nature;
- Short-term ITS deployment needs outweigh future technology in importance; and
- Soft skills (communications – speaking, writing, analytical ability) are highly valued, especially as individuals advance.

Additional **perspectives from the public and private sectors** included:

- Transportation/traffic engineering is foundational
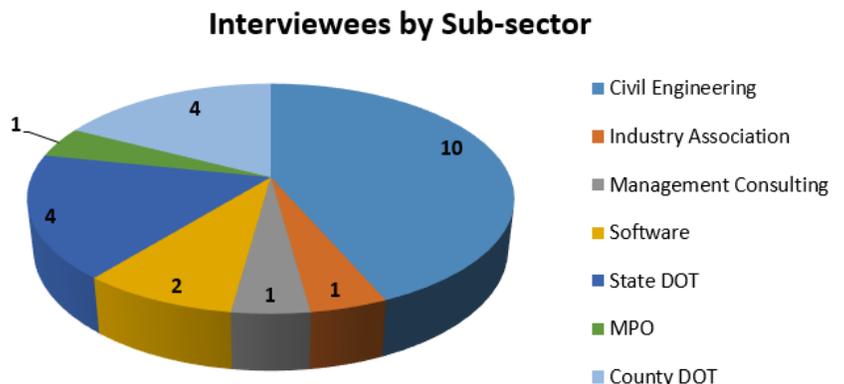

Figure 2: A graphic from Anthony Shaw's presentation shows interviewees involved in the workforce study categorized by subsector.

- Operations knowledge should be leveraged to inform design
- Interdisciplinary knowledge is increasingly important
- Soft skills!
  - Written/verbal communications
  - Willingness and ability to learn independently
  - Task/project management and contracts administration
- No university pipeline – no single major on which to rely for candidates
  - Candidate pool lacks education, training, and experience in ITS
  - ITS training occurs on the job
- Public Sector must compete with private sector for limited candidate pool ()
- Job specifications need to be opened up to successfully widen the candidate pool for the Public Sector
- Career paths in the Private Sector move towards task/project/program management and business development
- Software and technology companies represent new directions for the ITS workforce
  - Come with their own unique needs

Feedback from select attendees regarding ITS education/workforce included:
- Teaching a series of skills and explaining the range of applications (ITS, transportation, or otherwise) is a good approach. Millennials will be interested if they feel the skill sets they are learning have valuable applications; they need to understand the big-picture benefit of what they're doing.
- One challenge is understanding what ITS is to begin with. This begins with talking about transportation as a system, beginning at the planning process – then see where ITS fits into this system all the way through. Especially at the undergraduate level, an overview course that establishes the context and industry needs would be valuable. Start at a general level and then become more specific.
- In terms of the workforce project, it is important to include the new/start-up job pulls and how that effects workforce challenges. Students receive offers from Uber and other tech companies which are much more appealing than what they perceive as the more dry offers from traditional established agencies. The result of this is a drain of younger employees from the transportation industry, especially from the public sector agencies. The students want to work for the new/growth companies and "make a difference," with a much higher salary.
- There has to be an incentivizing system to encourage trained workers to stay in their public sector job. Without this, young workers are trained and once they learn these career specific skills, they become valuable to the private sector and leave for a higher-paying job.
- We need to broaden outreach. There are young employees who are a good fit for public sector work, they just need to know about these opportunities.

A request for feedback was made to the workshop participants and next steps were listed as follows:
- Reconvene ITSA Student Chapters, instigated by professors or a planned event
- Reach out to universities with guest speakers
- Consider how to reduce barrier to ITSA membership (cost was noted as a barrier for some)

National Operations Center of Excellence (NOCoE) – *Workforce Development*

Patrick Son, NOCoE, Managing Director

Steve Lavrenz, NOCoE, Technical Services Manager

Presentation slides available here

https://connectdot.connectsolutions.com/itspcbunivws_d1_4/

Patrick Son (NOCoE) gave a presentation entitled *Workforce Development for the TSMO Community: An Emerging Strategic Direction*. The presentation began with an overview of the June 2016 NOCoE TSMO summit, then the current state of the industry, issues for the summit to address, summit participants, emerging strategic direction, and next steps. The June 2016 Summit grew out of the acknowledgement that "workforce capabilities are recognized as an increasingly

crucial component of realizing the potential of new ITS technology and TSMO applications" (from presentation). In September of 2015, NOCoE was charged with focusing on TSMO workforce development as the centerpiece of its first strategic work program and Annual summit. The summit addressed two core issues:

1. **Competencies, Education and Training**
   - Pre-employment education aimed at producing TSMO generalists
   - Pre-employment education aimed at producing key TSMO-related technical specialists
   - Position and qualifications specifications (KSAs)
   - Employment training programs

2. **Recruitment, Retention and Career Development**
   - Keeping pace with emerging trends in technology/skills
   - Recruitment
   - Career development
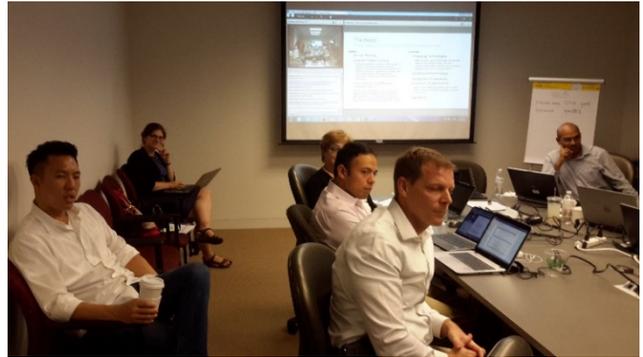   - Retaining top performers

Figure 3: Patrick Son of NOCoE (left foreground), Sara Davidson of ITSA (back left), Randy Johnson of Missouri DOT (front center), Carlos Alban of ITSA (middle behind Randy), Teresa Adams of Midwest TWC (behind Carlos), and Raj Ponnaluri of Florida DOT (far right). Source: Volpe Center

The Summit summed up the **Priority Action Item Implementation Strategies** as follows:
1. **Pre-employment education for TSMO generalists and key support specialists**
   a. Forum of DOTs, private sector, and educators (2*)
   b. Add existing programs and course materials into EKTS (1*)
   c. Curriculum development for educational institutions & training programs (1*)
2. **Position and qualifications specifications (KSAs)**
   a. Repository of similar existing PDs/KSAs; create model position descriptions based on position/function matrix established in previous research (2*)
3. **Employment training program**
   a. Review best practices for TSMO training policies (for new hires, promotions, and transfers); create model TSMO training programs (3*)
4. **Recruitment**
   a. Document public/private entity best practices, including targeting non-CE disciplines and recruitment sources, recruitment "sweeteners" (e.g., signing bonuses) (2*)
   b. Develop a strategy to elevate TSMO visibility as a core transportation function (2*)
5. **Career development**
   a. Document best practices in mentoring, succession planning, cross training, special assignments, and individual career planning for public/private entities (1*)
6. **Retaining top performers**
   a. Review current practices for rewarding performance (1*)

Transportation Workforce Centers (TWC) *Perspective Regarding ITS Workforce Challenges*
Clark Martin, FHWA, National Transportation Workforce Center (NTWC) Program Manager
No presentation slides available

Clark Martin (NTWC Program Manager) introduced the USDOT's Transportation Workforce Center (TWC) Program, as well as a representative from several of the regional TWCs. The goal of this section was to describe the overall TWC program, and the regional TWCs including their focus area and technology initiatives, and how the TWCs might fit in

with other initiatives. Clark described how the TWCs are sponsored by FHWA to break down barriers, not to replicate programs, and their aim is to facilitate dissemination of information.

Workforce Challenges
- Increasing baby boom generation retirements
- Declining US labor rates
- Competition from other industries
- New technologies require new skill sets
- Challenge to reach underrepresented groups
- Transportation need exceeds available resources
- Need for an efficient and effective workforce for a greater return on investment
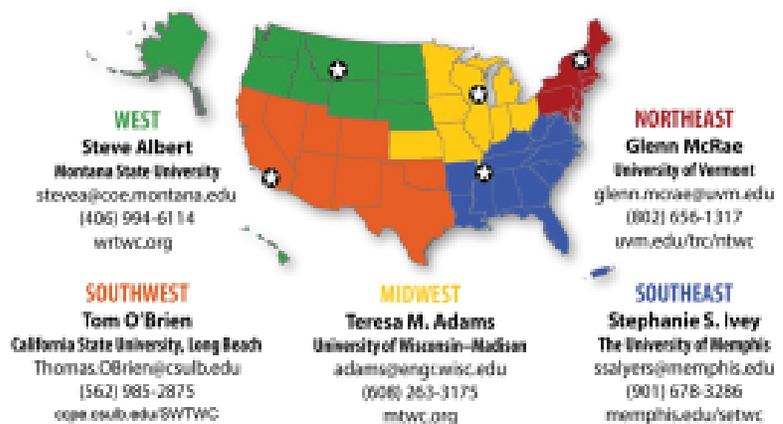
There are five regional TWCs around the country, all with a different focus area, but all serving workforce needs of their region. The purposes for the Surface Transportation Region Workforce Centers are to:
- Connect the many good programs, that are generally disconnected
- Increase the strategic and coordinated efforts
- Utilize existing resources
- Stimulate partnerships across transportation, education, workforce, and labor
- Promote successful practices at all levels.

Figure 4: The Five Transportation Workforce Centers and workforce challenges as identified by the TWCs.

Stephanie Ivey—Southeast TWC Director at University of Memphis (The U of M)

Southeast TWC's focus areas are: women in transportation, freight and logistics, and military transition to transportation workforce. Some of the current initiatives are: piloting a STEM project with a local high school in an effort to recruit high-schoolers into transportation careers and looking at ways to integrate ITS into the curriculum. Exposure at this level will help because high-schoolers are attracted to many aspects of ITS. Another initiative is looking at what can be done to help women transition with retraining and reentry into the workforce as a transportation professional. Collaboration across pipeline is this year's theme.

Tyler Reeb—Southwest TWC Assistant Director at Cal State University at Long Beach (CSULB)

Southwest TWC's focus areas are:

1. ITS: we are looking at integrative ways to bring together different players in the workplace.
2. 21st Century operations. Implementing the notion of career path and outreach from K-12 through tech school, community college, university, and targeted workplace learning initiatives, as positioned to identify transformational technologies. Part of this is bringing students into the workplace through apprenticeship programs especially those tied to innovative technologies.
3. Technology pilot tests in the real world. We are trying to get students equipped as well as get researchers out of the lab and into the workplace.

Teresa Adams—Midwest TWC Director at University of Wisconsin-Madison (UW)

All TWC's are facilitating partnerships rather than developing curricula. The focus is on how to make the most of resources already out there. All TWCs are working on creating a databases of resources in the region—education resources at all levels, professional organizations, and community colleges in addition to universities. We focus on engineers. We have facilitated HR people from state DOTs to have peer discussion across states to discuss how they're recruiting, training, writing job descriptions, etc. They are a partner on campus—career locker—where students can do tests to find out their skills and find out about occupations. We build content for that group that's related to transportation jobs. We're also building a library of success stories—at-risk students, returning vets, returning citizens (incarcerated), and how these people have entered transportation jobs. There is an untapped pool of workers out there that this initiative is reaching out to.

Figure 5: Teresa Adams of the Midwest Transportation Workforce Center speaks, with Carlos Alban on her left and Patrick Son behind.

The other two TWCs, *not present*, were also discussed by Clark Martin.

Northeast TWC at University of Vermont (UVM) Glenn McCrae – NETWC Director

Northeast TWC focus areas are community colleges, planning, and environment.

West Region TWC at Montana State University (MSU) -Steve Albert - WRTWC Director (also Western Transportation Institute Director)

WTI focus areas are safety, rural transportation, and Native American interests. They look at private-public sector and the education continuum across many disciplines.

After hearing from Stephanie Ivey and Tyler Reeb on the phone, as well as Teresa Adams who attended in person, Clark Martin wrapped up the session emphasizing that there is a broad brush to address. The centers were established in October 2014 and funded through a grant program. TWCs help communicate and coordinate across education, workforce, and transportation communities. The first year (2015) was spent reaching out, identifying stakeholders, workforce needs, partners, and researching data. The second year (2016) was spent working on partnerships and establishing substantive relationships with results. Identifying partners and groups who are successfully doing like work has been key to collaboration and information-sharing.

Clark then described the upcoming Transportation Strategic Initiative scheduled for fall 2016 that will lead into the 2017 focused effort by the NNTW to engage communities and conduct further work with the existing organizations. He explained that there are opportunities and great needs to work with key organizations to compliment what's already being done, as they can't be everything to everybody. The Transportation Strategic Initiative is an effort to focus five discussion points: (1) safety, (2) operations, (3) planning, (4) engineering, and (5) environment. They each look at curriculum at three levels: university, community college, and technical school. The intent is to complement the initiatives of NOCoE and others represented at this University Workshop. The ITS operations community will direct this initiative to further the work from existing programs.

Emerging ITS Needs

One of the workshop objectives was to identify any emerging ITS educational/workforce needs. ITS, being technology-based, can evolve quickly, and the knowledge requirements can change within a matter of years. Identifying emerging needs will help professors prepare their students so that when they graduate, they're armed with the knowledge that's currently needed.

To help identify the emerging ITS needs, representatives of State DOTs working on cutting-edge ITS deployments were invited to discuss their observations about the emerging needs, and federal representatives were asked to provide their insights regarding how ITS is evolving and what the ITS professional will need to know in 4-5 years.

State DOT Perspectives

Grant Zammit, FHWA Resource Center, Operations Technical Service Team Manager
Presentation slides available here https://connectdot.connectsolutions.com/itspcbunivws_d1_5/.
Links each State DOT presentation are provided below.

State and local DOTs are advancing the frontier for implementing ITS technologies. As these agencies begin to implement new and complex technologies, they may encounter new, emerging, or future capacity needs for ITS professionals. The purpose of this session is to identify the future ITS educational needs. Grant Zammit introduced Paul Szatkowski from VDOT, Randy Johnson from MoDOT, and Raj Ponnaluri from FDOT.

During each presentation, speakers were encouraged to discuss their projects and respond to the following questions, based on their experiences:
- Describe the ITS projects you're involved in. What is your role in those projects?
- Describe the technical content that you need employees to be educated about in order to competently work on this project.
- Based on your experience, what are young engineers well-equipped to do, and what is missing from their education?
- Based on your experience, what are the emerging and/or future educational needs within the next 5-10 years?

Paul Szatkowski, Virginia DOT (VDOT), Assistant Division Administrator, Operations Division (Richmond, VA)
Discussed talking points over the phone. No PowerPoint presentation available.
- Emphasis in Virginia is not to build new roads or heavy infrastructure but to make better use of what's available, such as alternative route information, variable message signs, park & ride information, ramp metering, and data for decision-support systems. Now we have this infrastructure, how to we integrate to make the best use of it?

- Workforce skills needed are **combination of civil and industrial engineering, human factors, and data analytics**
- Very important is to understand how to **integrate systems,** besides the basics electronics and traffic operations
- Need those who can **understand the purpose of a system or process, how it can be applied, and used well**
- Need to be able to **look to the future**, see how technologies are changing, and can design with this in mind
- Need leadership to set policy and oversight, without restriction by hard policies, but ensuring interoperability

Randy Johnson, Missouri DOT (MoDOT), Kansas City Scout Manager
Presentation slides available here https://connectdot.connectsolutions.com/itspcbunivws_d1_6/

Figure 6: A slide from Randy Johnson's presentation describing one of MoDOT's ITS projects.

The I-70 Road to Tomorrow is a technology test bed. Why are we doing it? Two reasons: (1) Integrate new technologies for MoDOT, (2) Enhance funding stream. About 80 projects have come in and there is a test site welcome center. It very much matters what customers (road users) like. Users of the road must be on board.

Figure 7: Randy Johnson (Missouri DOT) presented what MODOT looked for in entry-level ITS engineers. Source: Volpe Center

Raj Ponnaluri, Florida DOT (FDOT), Traffic Operations Office - Arterial Management System Engineer (Tallahassee)
Presentation slides available here
https://connectdot.connectsolutions.com/itspcbunivws_d1_7/

- Florida is working on the TSMO Strategic Plan to be consistent with industry areas—stakeholder management, deployment (including before and after evaluation), training workforce development. Other projects now are Signal Phasing and Timing (SPaT) challenge, hard shoulder running, human factors with wrong-way driving, use of big data, and integrated corridor management (ICM).
- Human factors for wrong-way driving especially when it comes to CV/AV. Florida has lots of data and big data is not only massive, but also complex.
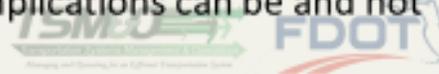
Figure 8: A slide from Raj Ponnaluri's presentation describing what's missing in young engineers' education.

Summary of Current and Emerging ITS Need - State DOT Perspectives

Each State DOT representative described specific skills and knowledge that an ITS professional needed within their state. In summary, according to State DOTs, entry-level ITS engineers should have competent skills and comprehensive knowledge about the following:

- **Technical content**—traffic operations, IT and utility systems, fundamentals of roadway design
- **Human factors**–how to accommodate for human factors in ITS design
- **Data management**—there is a lot of data available but we need people who know how to use it
- **Communication**—how to present data to various audiences
- **Economics**—understanding of how market forces and policies influence ITS projects
- **Creativity and innovation**—not just STEM knowledge (the same type of thinking that made the problem will not resolve it)
- **Ability to evaluate systems**--network communications, traffic engineering, capacity, calming, modeling, signal control, understanding of multimodal systems, and public policy
- **A sense of time horizon**, implementation, and future-thinking
- Consideration of **how future innovations will impact** what we are doing now

Figure 9: Raj Ponnaluri of Florida DOT (left) and Andy Berthaume of USDOT ITS PCB Program (right) were two of the seven participants in one of the three breakout groups that defined the knowledge and skills an entry-level ITS engineer should have. Source: Volpe Center

- Ability to work with and language to **communicate with a multidisciplinary team**
- **Technical competence**
- **Field level understanding**—know how to inspect ITS field devices, how units function
- **Knowledge of funding programs**, where funding comes from and how it can be used

Federal Perspective

Alexander Schroeder, Senior Advisor, Office of the Assistant Secretary for Research and Technology (OST-R), USDOT

Presentation slides available here https://connectdot.connectsolutions.com/itspcbunivws_d1_8/

Alexander Schroeder gave his perspective on the needs of government agencies to be addressed in education. Mr. Schroeder's primary points covered were:

- All government agencies are doing more with less
- Attracting young people to the public sector is difficult given the pay in the private sector
- USDOT is looking at the cross between DOT and the Department of Energy (DOE), specifically (1) safety, (2) mobility, (3) environment
- Interdisciplinary learning and research is becoming increasingly important. There is an increased need for cross-disciplinary and multi-agency teams and skill sets
- Chief innovation officers and embedded technologists can add technical capacity to an agency and provide for enhanced learning opportunities by all parties within the agency
- Increasingly complex stems require new approaches such as machine learning, artificial intelligence, and enhanced approaches to data management and collection
- New approaches to enhancing the application of technologies also require novel social and ethical considerations
- Cybersecurity is a significant cross-cutting issue that demands the implementers to ask, "What are security risks?"
- Innovation is more than technology; it's also culture, process and a practical skill. Innovation needs to be brought into the workforce in this comprehensive way.
- Data is important to collect, but we need people to use and relate it properly
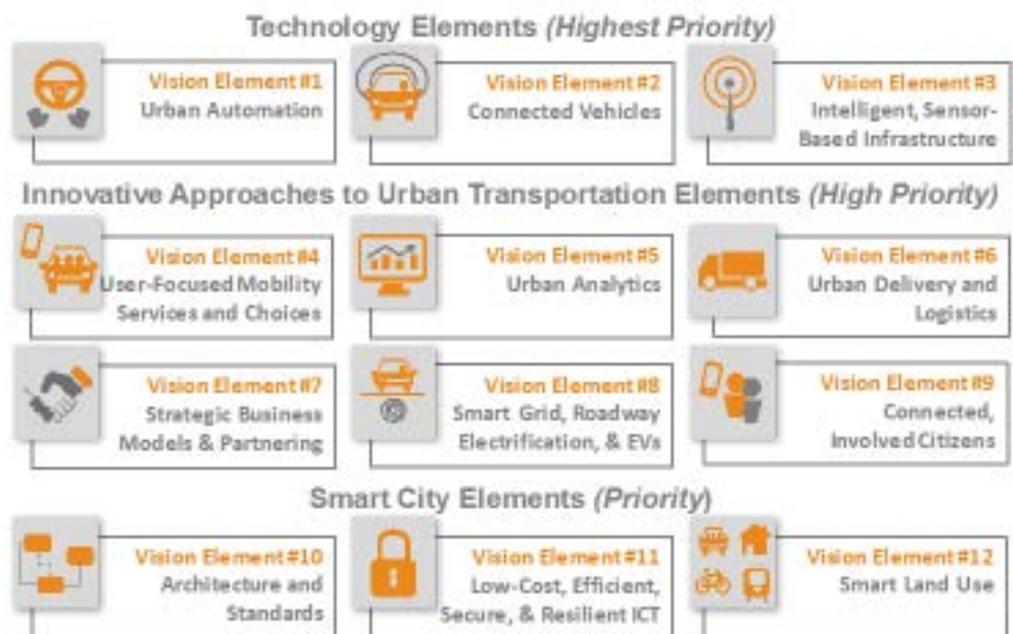

Figure 10: A slide on the Smart City Challenge from Alexander Schroeder's Presentation

Emerging Needs Panel Discussion (State DOT/Federal Perspective)

Presentation slides available here https://connectdot.connectsolutions.com/itspcbunivws_d1_5/

Grant Zammit led the discussion by the State and Federal group on the emerging needs collectively, elaborating on the main points and talking about the dynamics of each need identified. Main discussion points included:

- MoDOT is big on training but not recreating the wheel; utilize what's already out there.
- FDOT uses opportunities to present ideas to its executive board. It is important to pitch programs to the highest level for buy-in, as well as to local audience to get positive feedback and share the feedback with upper management.
- The ITS PCB Program wants to ensure consistent basic training can occur from state to state.
- FDOT uses NOCoE and other materials, as well as develops their own materials for state-specific training and knowledge sharing needs.
- Noblis (an ITS PCB Program team member) emphasizes that traffic operations are attractive for those permanent staff and temporary student staff (trainees, fellows, interns) who do rotations so that they will return.

Defining ITS Educational Needs

The participants at the workshop broke into several small groups to discuss the questions below, based on their experiences and what has been presented at the Workshop up to this point.

- *Based on the presentations and discussion so far, what is your perspective on the most urgent ITS educational needs?*
- *Which current needs are most important and which future needs should be addressed now?*

Most Important Near-Term Educational and Professional Needs (KSAs)

- Systems engineering perspective
- Data analytics skills
- Connected vehicles knowledge
- Dealing with user-interfaces. How we integrate and involve smartphones or technology in cars? (This can provide huge accessibility impacts as population demographic is shifting.)
- Equity and access to transportation. Florida is looking at EBT card for transit.
- Microsimulation skills applied to specific corridors and to observe/model interaction of vehicles. (Better modeling would enable customized modules in the system).
- GIS analysis and mapping of infrastructure, vehicles, etc.
- Data security. It is increasingly important for people to recognize vulnerabilities as more vehicle and transportation operations is automated or dependent on machine learning. Professional need to understand how to identify if data is compromised and steps to take to correct that situation.

Most Important Long-Term Needs

- Knowledge of automated vehicles
- Knowledge of human factors
- Machine learning, especially how to screen noisy data like the word "accident" on twitter, etc.

Most Important Needs (In General)

- **Communication skills**—Technical skills may get you the job but communication skills will advance you. We are constantly getting feedback that the students cannot communicate. They need to be able to present to diverse audiences, write well, explain designs for consensus-building, etc. Students must be aware that this is a job requirement in transportation engineering and any ITS-related work.
- **Broad/critical/interdisciplinary thinking**-- Engineers do not want to take non-STEM electives. Students are being told STEM education will make them successful, but reality shows it only gives the hard skills. They need emotional intelligence, conflict resolution, broad-minded problem-solving skills that go beyond engineering thinking and beyond what the industry needs right now, but what the future needs will be.
- **Identify role of university education vs. on-the-job training.** This will require a continued or expanded coordinated effort so the employers will understand just how far the education process can support the next generation of transportation professionals.
- **Keep in mind turnover**—revolving door for staff occur at big consulting firms as well as State DOTs. Expect that the current class of students will be changing jobs often.

Closing

Andy Berthaume (Volpe) closed the day by providing a summary of day 1 and charge for day 2.

The Need.

What do today's and tomorrow's entry-level ITS professionals need to know, and what abilities should they be armed with?

Abilities

Critical Thinking.

Creative Problem Solving.
Traditional problem solving methods / approaches taught in STEM programs may not always yield the optimal solution. ITS professionals would benefit from a diverse background / experiences to draw from when problem solving. This may involve experiences outside the traditional STEM curriculum.

Clear, Concise, and Effective Communication.
Not just clear wording, but communicating the right content to the right audiences using the right mechanisms. (For example, you wouldn't tell a decision-maker about the technical details; you'd tell them about the benefits of the system).

Knowledge

Emerging Technologies.
What are they, how do they work, how can they enhance an existing system, how does someone obtain them, and how does someone integrate them into an existing system.

Established terminology.

Established frameworks, processes, & approaches for the design, operation, & maintenance of ITS systems.
About them, what they contain, how to apply them, and any specialized knowledge required to use them. [Examples: SEP (USDOT); Con-Op Standard (IEEE)]

Standards.

Figure 11: The Need: Abilities and Knowledge, as identified by workshop participants on Day One.

Workshop Day 2

Recap of Day 1, and Overview of Day 2

Andrew Berthaume, USDOT/Volpe Center

Presentation slides available here https://connectdot.connectsolutions.com/itspcbunivws_d2_6/

Andy Berthaume (Volpe) summarized the main points of student need, split into abilities and knowledge. *What do today's and tomorrow's entry-level ITS professionals need to know, and what abilities should they be armed with?*

- **Abilities**: critical thinking, creative problem solving, and clear, concise, and effective communication.

- **Knowledge**: Emerging technologies, establishing terminology, established frameworks, processes & approaches for the design, operation, & maintenance of IT systems, and standards.

ITS PCB Program – Existing Academic Resources

This section described the various ITS Academic tools that have been developed (and some deployed) based on feedback received during the 3rd University Workshop. The tool developers explained the purpose of each tool, and users described their experience and how the tool helped them achieve their goals.

ITS PCB Program Products Overview

David Jackson, USDOT/Volpe Center

Presentation slides available here https://connectdot.connectsolutions.com/itspcbunivws_d2_1a/

David Jackson (Volpe) gave an overview of the goals of the ITS PCB Program:

- ITS PCB Program developed to create technically competent ITS workforce
- Broadened definition of workforce to elected officials, business leaders, students at community college
- Expand offerings from webinars and live trainings, now workshops, and extend to other audience through professors, partnering with higher education
- We work with partners to reach new audiences such as ITS America, Noblis, CITE, Nanosonic, NOCoE, etc. We want to keep increasing our partnerships, such as with SAE international.
- 4 Tiers: are we training for now, or are we training for the future?

Figure 12: A slide from David Jackson's presentation, describing background information on the ITS PCB Program.

ITS Case Study Pilots

In a previous workshop, it was noted that students needed an opportunity to apply field concepts while in a classroom setting. To address this need, ITS Case Study lectures were developed for topics such as adaptive signal control, national ITS architecture, ITS concept of operations, civil design considerations of ITS implementation, travel time based performance measures, transit service and ITS. The Case Studies have been piloted at three locations: University of Massachusetts at Amherst, Florida International University, and Gonzaga University.

Cliff Heiss—Developer, Iteris

The purpose is to convey systems engineering process (SEP) to students. It is designed to be modular and to be incorporated into existing curricula. The content will need to be refreshed when ITS National Architecture is updated.

Kathy Frankle—University of Maryland [Travel Time Reliability Course]

The purpose was to convey SEP to students and it was designed to be modular.

Users of the Case Studies were asked to address the following questions:
- Were the case studies useful?
- How were they beneficial?
- What information did they help teach, and what additional information is needed?

Eric Gonzales, University of Massachusetts at Amherst

Effective at teaching SEP and Con Ops, but need to be integrated into an entire course (not just one day). The module was structured so that it could be trimmed to fit time limits. Students grasped SEP process and understood con ops. The challenge is integrating these materials developed here into the curriculum beyond the first day; need a mechanism for re-introducing these concepts throughout a course curriculum.
Prerequisite: An additional course to help introduce ITS jargon would be helpful as a precursor to this course.

Mohammed Hadi, Florida International University

Effective for building interest in ITS. Module content was deployed to both graduate and undergraduate students. The course built interest in ITS in undergraduate students.
Prerequisite: ITS Con Ops Course

Rhonda Young

Effective at incorporating ITS considerations into existing Civil Design Courses. Demonstrated how ITS fits into transportation.
Prerequisite: ITS Con Ops Course

Overall, how were Case Studies helpful?
- Good way to teach a new way of thinking on systems engineering process concepts
- To really be effective, it needs to be embedded in course curriculum
- It is effective in in understanding of big picture
- There's a lot of jargon in ITS. If they don't have a background in the terminology, they can be lost in those details—be aware of this.
- Examples are important—some professors added their own. The structure allows for examples included within or to be added by professors. Professors can use things students would know about and relate concepts to examples on campus, such as transit service.

Do you have prerequisites?
- Not for graduate students
- For undergrads, it's important to pick the sessions carefully, being selective about what things to give them leading up to the module.
- Multimedia videos are useful in introducing basic concepts in the beginning, then go deeper once in the module.

Comments from the audience
- **Students want to use math**. They take homework and bring it back to class and talk about it. It's an ITS topic and they don't necessarily realize they're learning ITS, but a good way to get it into curriculum.
- **It is useful to incorporate things on campus into students' learning**, such as AVL station at bus stop. Students can easily understand for example, when is the next arriving bus, and it is a tangible way to understand a given ITS concept.

T3e Webinars

Jaime Young, USDOT/Volpe

Jaime (Volpe) gave an introduction on the purpose, format, and process of the T3e webinar initiative. She listed the four webinar topics and speakers that have taken place so far, and offered spaces available for anyone interested to present in the upcoming months to speak to her to schedule. Register to view at: www.pcb.its.dot.gov

Figure 13: Jaime Young, David Jackson, and Andy Berthaume of the USDOT ITS PCB Program.

Purpose
T3e's are envisioned as a forum to bridge academic research with the larger transportation community. The goals are multifaceted and aim to:

- Allow transportation professionals to learn about emerging trends and interact with academia.
- Provide students an opportunity to present their work to the professional community and perfect their presentation skills.
- Offer an opportunity for academic institutions to showcase their programs and labs to a national audience.
- Provide those in all sectors with an opportunity to network and find synergy, potentially forming partnerships for deployment, operations, or new research topics.

Format
- Focus on a specific ITS topic, theme, or subject area
- Up to 60-minutes in length--the first 25-40 minutes is devoted to presentations on relevant research, while the remaining 20-30 minutes are set aside for an interactive question and answer discussion.
- Presenters may be university students, staff members, researchers, or professors but usually includes multiple presenters.
- T3e's present a unique forum for exchange between academia, government, and industry.

Process
- Because the T3e's are focused on academic research, unlike other T3 webinars, T3e presenters come exclusively from academia.
- In contrast to traditional T3's which are hosted by a federal DOT staff member, a professor will serve as the host on a T3e webinar.
- The T3e Webinar content is developed by the professor and presenters, who determine the topic(s) and learning objectives.
- All T3e's are produced by the Volpe Center T3 team who works with professors and students throughout.

Figure 14: (left to right) Alexandra Dudley (FHWA), Haizhong Wang (Oregon State University), Kevin Heaslip (Virginia Tech), and Xiaopeng (Shaw) Li (South Florida University). Source: Volpe Center

T3e Pilots
Professors who hosted early T3e Webinars discussed their experiences, as well as the benefits these webinars provided:

Haizhong Wang – Oregon State University
- **T3es are effective ways to share your research with potential end-users.** Approximately 100 individuals attended the webinar. Future work came from these presentations.
- **Graduate and Undergraduate students learned how to Communicate Effectively.** Graduate and undergraduate students paired up to create these presentations. They learned how to effectively present and communicate to a larger audience, especially with such technical information.
- The rehearsal/dry run before the webinar was very helpful. The students learned how to more effectively communicate in a webinar; the dry run identified specific ways to improve each communications in each presentation. Students reviewed the recording post-webinar, looking for additional opportunities to improve their communications; this helped remove the "um's."
- **Would've benefitted from more time for Q&A after the webinar.** Although there were follow-up questions that were asked post-webinar, directly to the professors/researchers.

Eleni Christofa – UMass Amherst
- **Helped my students organize their thoughts.** My students hadn't formally organized their thoughts before (in a presentation). The webinar was an opportunity to organize their thoughts and think about how they would present to a larger audience.
- **Helped students see how their research was related.** The students needed to create a "theme" for the T3e. They looked for commonalities, and were able to see the common thread between what they were doing.
- **Doable when you're not on campus.** Eleni was in Belgium during the presentation, and was still able to do this.

Cathy Liu – University of Utah
- **The post-webinar statistics helped demonstrate impact.** Jaime sent post-webinar statistics that helped the students see the impact of their research, and of the T3e presentation.

Other thoughts/feedback regarding T3e webinars included:
- **Collaboration**. Webinar led to more collaboration—we advertised the webinar to our networks and after the webinar had half-day meeting with ODOT in order to brainstorm and convert to research ideas on how emerging technology will change peoples' travel behavior in the state of Oregon.
- **Communication**. Students learned a lot from the experience. We had rehearsals, videos to practice, etc. and ran through the recorded version by ourselves to see what we could do better. The dry run is also very helpful to practice and refine the presentation and help students distill main points of research for a varied audience.
- **Awareness**. It has given a space for interested undergrads to find out more and participate in this kind of research, since we advertised it to our on-campus community.
- **Continued Conversation**. We didn't have enough time to address all questions from the audience and we wanted to keep the conversation going. One improvement could be to capture and forward the audience questions. Our follow-ups are still moving forward and others contacted us also after the webinar.
- **Incorporate TWCs**. One idea is to use TWCs to advertise to a larger audience—all TWCs have websites that could link. Intentional marketing of products is one issue we'd like to address.
- **Seminar series**. We have a seminar series with a different speaker every time. T3e's could be used for seminar series when we don't have a speaker, which happens from time to time.
- **Student clubs**. The transportation club—could also be a good group to share it with and have a screening, or share links with them.
- **Understand Audience**. Webinar statistics were helpful for students to see where audience came from.
- **Practice in effective communication**. It was good practice for students to get organized, write down exactly what they wanted to say, and make the presentation refined. One student presented his dissertation in June and was well-prepared because of this.
- **Relatability**. It was also helpful for them to see how three research topics came together and were related. Good to squish it into 12 minutes.

Curriculum Webpage

Andrew Berthaume, USDOT/Volpe Center

Andy Berthaume gave an introduction on the purpose, goals, and role of educators for the curriculum webpage initiative. He presented a mockup of the page and said where it will be found within the ITS in Academics webpage (http://www.pcb.its.dot.gov/academics.aspx)

Purpose
To publish information about ITS courses in order to provide:

- Prospective graduate & undergraduate students interested in ITS with a "one-stop-shop" resource with information on university ITS programs & courses; and
- Educators with a platform to feature their ITS courses and an opportunity to informally network with other educators, exchanging lesson plans and best practices.

Figure 16: Cathy Liu of University of Utah (right), Eleni Christofa of University of Massachusetts Amherst, (middle) and Clark Martin of National Transportation Workforce Center (left). Source: Volpe Center

Educators can help develop this into a meaningful resource by providing us with:

- A list of your ITS courses, along with one or two web links to course descriptions/information
- A two-to-three sentence description that sums up ITS-related initiatives at your institution
- A university point of contact, and
- A university logo that we can publish on our website

The webpage will ultimately feature a comprehensive list of educational institutions that offer coursework in ITS, connected vehicles, automated vehicles, smart cities, or other innovative transportation research, and provide links to curriculum information and ITS-centric programs.

There were questions as to how the webpage relates to the Google Group. The webpage would be different in that it is more of a resource for professors to see high-level what's going on around the country in terms of ITS curriculum, not necessarily to share documents. However, it could lead to more sharing of information privately as webpage users form networks.

Consortium for ITS Training and Education (CITE) Courses and Material

Kathy Frankle, University of Maryland (CATT-CITE) – ITS PCB Program

Presentation slides available here https://connectdot.connectsolutions.com/itspcbunivws_d2_2/

- CITE materials were designed for two audiences: **industry professionals and professors at universities**.
    - o **In-depth for industry professionals**. Have focused on industry professionals—means courses are more in-depth on a particular topic but not breadth.
    - o **Breadth for university level**. Universities may have more interest in breadth such as intro to ITS. We are trying to keep courses that a university would want more up to date.
- **Online availability**. Materials are online and by doing this, we did not have to wait for classroom course to come around or for educators to develop their own course. Different universities use the info at different times in different ways and online accessibility enables this adaptability.
- **Blended course for flexibility**. Blended courses: 6-8 week timeframe that the course is available so students may do it on their own time. Rates of completion went from 50% to 95% with the blended style and conference calls have been successful at engaging participants.

- **Certificate programs**—three core courses and three electives. Cheaper for students to bundle them together.
- **Continuing education**. Many offerings for people in a given discipline to learn about something they need on the job that they didn't get in school. For example IT people in a DOT don't know about transportation systems so can get a background in that. People are using courses for all different reasons.
- **New Courses**—travel time course goes along with case study, so students could do these together.
- **Interactive PDFs**. In addition to online, we have interactive PDF files that students could download and wouldn't even have to be online. We're in the process of putting all in this format to make them accessible for various types of users.
- The courses have narration, knowledge check quiz, etc.
- **Cost**. CITE is free to universities and public agencies.
- **Feedback**. CITE is open to making changes when things are not optimal. Is there a new topic they need to cover?
- **Community college outreach**. This would be useful since it's a pathway to 4-year schools, but hard to reach all 1,300 of them and people on staff change, so it's a constant job to keep them all informed. Useful to connect with National Association of Community Colleges.

Figure 17: Two slides from Kathy Frankle's presentation listing CITE's available courses.

Other ITS PCB Program Resources

Presentation slides available here https://connectdot.connectsolutions.com/itspcbunivws_d2_3/

ITS Primer

- Collaboration ITE, APTA and ITS America
- 14 online modules, with multi-media examples
- Key elements include:
  - Technical content
  - Navigation to individual modules
  - Links to video and interactive material
  - Training and resource links
  - Feedback links
- Posted 2014
- Updates 2016-2017
  - 4 webinars in March 2016 covering 7 updated modules
  - The 7 remaining modules will be updated in 2017 and 4 subsequent webinars will be produced
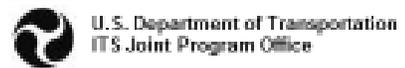

Figure 18: Clark Martin of the TWC speaks (standing). Also pictured are Stan Caldwell (Carnegie Mellon University), Cheryl Lowrance (Noblis), Kathy Frankle (University of Maryland), Billy Williams (NC State University), Grant Zammit (FHWA Resource Center), and Randy Johnson (MoDOT). Source: Volpe Center

Figure 19: Slide from David Jackson's presentation listing the ITS ePrimer modules.

ITS Standards

- FREE, 1.5-2 hour modules that teach how to procure, implement, and operate ITS standards-based devices
- The modules are narrated and archived on the ITS PCB website
- First series of standards modules posted in 2013
- 48 general ITS Standards Training Modules currently online
- 11 ITS Transit Standards Training currently online
- New ITS Training Modules in 2017:
  - 10 ITS Transit Standards
  - 8 new ITS Standards
  - 8 existing ITS Standards modules are being updated
  - A total of 21 ITS Transit Standards modules posted online by March 2017
  - A total of 56 ITS Standards modules posted online by October 2017
- Approximately 800 have registered.
- The early overview modules remain the most popular, while the later versions are the most technical in content.

Small Business Innovative Research (SBIR) Grants

- Using SBIR Grants since 2014
- 2 SBIR-funded trials underway to develop ITS-CV educational lesson plans for secondary and higher education use (NanoSonic and IGD)
- Small businesses plan to expand their educational products well beyond their partner schools over the next couple of years.
- NanoSonic, Inc. (Dr. Richard Claus)
  - Secondary education ITS-CV curricula and supplemental demonstration packages
  - Giles County School District, Virginia
  - Completion September 2017
  - Connected Nanosonic with the Department of Education. Phase 2 scheduled for completion in September 2018.

Figure 20: USDOT ITS PCB Program academic team members: Andy Berthaume (Volpe), David Jackson (Volpe), and Michelle Noch - ITS PCB Program Manager (not pictured: Jaime Young-Volpe). Source: Volpe Center

  - Middle and high school teachers have doubled after school program attendance by putting in these hands-on programs. Trouble is that after school programs compete with a lot of other activities for these students.
  - Summary sheet on NanoSonic's SBIR tasks and weblinks
- Integrated Global Dimensions, LLC (Valerie Lefler)
  - Transportation Tech: Community Colleges / Technical Schools ITS-CV Curricula and Credential Development (resource catalog & network)
  - Metropolitan Community College in Omaha, Nebraska
  - Completion September 2018
  - Summary sheet on IGD – Transportation Technology tasks and weblinks
    - Worldwide Business with Kathy Ireland: Next Generation of Transportation Professionals (article)
    - Worldwide Business with Kathy Ireland: Next Generation of Transportation Professionals (video)
    - Transportation Tech Blog

T3 Webinars

- Online, 90 minute, interactive seminars
- FREE by ITS PCB Program
- Past webinars available through T3 archive (posted 3-4 weeks after live event)
- Professional Development Hours (PDHs) eligible
- Invite T3 Webinars proposal:
  - Highlight an ITS related case study, problem solving challenge, or topic
- To join announcement list:
  - Send email to T3@dot.gov with the subject line "Add to Email List."
- Just added to T3 Archive:
  - Supporting Freight Operations with ITS
  - Connected Vehicle and Rural Road Weather Management
- T3 Webinar Series:
  - Automated Vehicle Awareness Series (2015-2017)
  - Open Payment Series (2016-2017)
  - Mobility On Demand Series (2017-2019)
  - Smart Cities Awareness Series (2017-2020)
- Register at: http://www.pcb.its.dot.gov/t3_webinars.aspx

Figure 21: A slide from David Jackson's presentation on the USDOT's T3 Webinar Series.

Institute of Transportation Engineers (ITE) Activities and Student Chapter Outreach

Lisa Fontana Tierney, ITE Traffic Engineering Senior Director

Billy Williams, North Carolina State University

Presentation slides available here https://connectdot.connectsolutions.com/itspcbunivws_d2_4/

ITE is uniquely positioned at the intersection of the public and private sectors, with members practicing at the federal, state, and local levels. ITE was founded in 1930 and is now active in more than 90 countries. ITE information:

- 14,000 members (45% public sector/45% private sector/10% academics and students (1600))
- 40 student chapters—great way of getting out information and trying to increase offerings for students
- Student Chapters are very active with lots of career resources available
- Students need to know their path—where am I going? What exactly are the occupations?
- ITS career resources up on website and on JPO website

Four tools have been developed for the ITS Joint Program Office:

1) Intelligent Transportation Systems: Is it the Right Career Choice for You? *(can be used at high school level)*
2) ITS Grand Challenges: How Can You Help Meet Them? *(this is more of a drill down in technologies)*
3) ITS Technologies: How Do I Prepare For a Career?
4) Three brief ITS Career Case Study Briefs

Other Workforce Tools

Cheryl Lowrance, Noblis

Presentation slides available here https://connectdot.connectsolutions.com/itspcbunivws_d2_5/

There are tools available, and under development, that can be used to educate students about Connected Vehicles. Representatives from Noblis and ITS PCB team discussed these Connected Vehicle training materials, explaining what they are, the type of information they provide, and where professors can access this information. PCB offers tools for awareness and training through courses and pilots to address issues of mobility and the move toward a CV environment. Several CV Pilot deployments are available and moving into Phase 2 design process. All CV pilot deployments are online immediately, archived, and live recordings are posted. There is also a Smart City site with the same process as far as resources are concerned. Webinars are also posted continuously. The tools available at this time are:

Figure 22: Cheryl Lowrance of Noblis (far left) explains the connected vehicle training materials and resources available through the ITS PCB Program. Photo Source: Volpe Center

- CV Deployments
- CV Pilots
- CV Training -
- ITSA State Chapter Workshops
- Additional CV/AV/Smart Cities training activities
  - ITS PCB CV Offerings
    - Connected Vehicle Reference Implementation Architecture (CVRIA)
    - http://www.iteris.com/cvria/html/resources/cvriatraining.html
    - http://www.iteris.com/cvria/html/forms/setittrainingform.php
  - T3 Live/Archived Webinars
  - ITS PCB CV Future Offerings (2017)
  - CV Pilot Deployment Resources
  - Smart City Resources

- Resources and Tools to Support CV Deployments
- Co-Pilot
- Connected Vehicle Reference Implementation Architecture (CVRIA)
  - http://www.iteris.com/cvria/
- Open Source Application Development Portal (OSADP)
  - https://www.itsforge.net/
- Research Data Exchange
  - https://www.its-rde.net/
- V2I Reference Implementation
- ITS Knowledge Resources

Figure 24: A slide from Cheryl Lowrance's presentation on the CV Pilot Deployment Program.

COPilot—a tool set up for pilot deployers during the proposal process. It will estimate the cost of doing project deployment, how many vehicles, upgrading signals, etc.

Open Source Application Development Portal (OSADP). All source code is available for students to access and use.

Research Data Exchange—all federal project research data must be entered here, and others can enter data too if they wish. This is different since ITE holds the data. For UTCs, USDOT will not hold this data; universities need to hold the data and provide links to access it. This is where these could coincide and will be investigated.

ITS Knowledge Resource Database. There are benefits that are based on prototypes and simulations. We're entering information and tagging it as V2I or V2V. When you pull it up it just lists summaries. Any federal documents included must have already been made public.

Other ITS Educational Tools & Challenges (Open Discussion)

There are effective ITS educational tools and practices that educators currently use. This open discussion allowed professors to talk about their current ITS educational practices, as well as discuss the resources that were introduced earlier.

What have professors found useful in terms of teaching tools or any of the resources discussed so far?

- **CITE materials and ePrimer** have been particularly useful for teaching graduate classes, while case studies have been useful for undergraduates.
- **Value of professional network.** It's valuable to have practicing professionals in front of the class, but professors must rely on their network to do this and those who are new the university and area do not necessarily have a network built up and available.
- **Weekly mini course**. It involves teaching an academic component, for example corridor management, and brings someone in who's done dynamic pricing. About 30 minutes presentation, 15-20 minutes for Q&A.
- **Need for engaging presentations**. What kinds of presentations are best for students—PowerPoint? Does not engage students to have a boring engineer show PowerPoint.
- **Trying to reinvigorate our peer program**. We have invitation-only webinars, "deployers' roundtable" and can be opened up to real dialog with open phone lines. They know the deployment issues as well as long and short term operations. Some might be tied in to our subject matter experts who have deployed.
- **In-class guest speakers**. This relies on a professor's professional network, or engaging with a local DOT.
- **Field tips and video of field trips**. We go to places like the statewide operations center or Raleigh traffic management center. We also video the field trips so online students can participate and ask questions (but not live); this is important as we have increasing amount of distance students.
- **Potential products**
  - A clearinghouse for speakers
  - A webinar series aimed at students, sent out to faculty as well, with interactive chat room
- **Professional contacts**. ITE, folks from regional DOTs—these kind of people can talk about ITS applications on the ground that students see every day but might not realize the importance of.

Use of materials and how to integrate them into a curriculum

- **Materials can be adaptable.** Cheryl at Noblis put together a course for a professor that contacted her, based on existing materials. Cheryl noted that most of the ITSPCB materials could supplement a lecture or lecture series, and/or could be used as a technical reference when building a new lecture or course.
- **Need a survey course** for those who don't go to grad school, as ITS practitioners often are not grad school grads. However, a survey course is tough to fit in when students also need the basic fundamentals. We cut down a lot of topics to make it a real survey course, also cutting out ITS sometimes, which may be the only way to expose them. This intro course is essential to introduce ITS.
- **Integrated textbook** with ITS concepts and emerging technologies, or possibly in a term paper. It doesn't need to focus on technical aspect, but at least give exposure.
- **Have the students teach**. One teaching tool is to read a chapter from the book and the students come up with slides as if they're teaching the chapter; they learn well this way.
- **Video teaching**. Students like videos of working through problems so they can always go back and see things they may have missed.
- **Stainable City Year Program—Smart Cities**. Programs like this present teambuilding opportunities and the student can present their findings with the public affairs director.
- **Build relationships with cities**. It may take a long time to build relationships but it's building a pipeline for students. Can be helpful to develop and MOA with the city, and students can work as class projects, internships, even real jobs.
- **Smart Cities Project.** It would be helpful to have documentation that universities could use.
- **MetroLab Network.** This is administrated from CMU (comes from White House initiative), similar to a smart cities initiative but a transportation group. City and university must just sign MOA to work together.

- **ITS Road Show**. Several years ago there was a bus that went around with all kinds of things inside as a showcase. It's been discussed again but nothing at the moment has materialized in this regard. Think about reviving it.
- **Videos**—JPO Communications Office can do them on request. If you think there are useful subject matter videos needed, let Michelle know.

How do we get all these resources to a wider audience?

A lot of resources are already here so the issue is not so much to develop new resources, but how to reach the appropriate audience.

- **Council of University Transportation Centers** (CUTC) annual meeting—a good forum to present at. Get on the agenda and get feedback from the group.
- **Established email blast.** Put this material stuff in established email blast, but judiciously. CITE looks at which lists to use –ITE vs T3 so as not to overload people with emails. There is direct email to all CUTC members.
- **ITS PCB mailing list.** This list just merged with TPMs mailing list. Now at 180 universities, but some are duplicates so not covering this many institutions necessarily.
- **Send from OST-P**
- **Use networks.** Have people send out to their groups, then you're controlling the message but giving it to others to distribute.
- **Use CUTC to isolate a university list**. Use a university focused list to tailor materials to what you think the university would be interested in. Build from this rather than go out to other organizations since this is already established.

Channels for learning and application:

- Package up the tools and ask the question, then provide applicable data sets.
- Hackathons are a great package. Utilizes students' skills-data analysis, building apps, etc. "This is your big problem, here are data sets" and let them use their critical thinking. Think about what happens on implementation side, if anything.
- Student Competitions
  - DOT challenges were popular for a time. Reward for winning was trip to ITS America. Where does it go afterwards? What to do with it with all this momentum?
  - Need some type of a program (we have data available, etc.) that can help them market, for example an app they developed, to have implementation, marketability, a financial return, etc.
  - Use a partner like InnovationWorks in Pittsburgh, or 1776 in DC to market it. It is for the good of the industry, supports small businesses, etc.
  - Make reward a mentorship from a small business partner to incubate a company. Smart cities challenge mobilized capital, mentoring, technical and business assistance. This could be done at a smaller scale at low cost.

Where does students' education come in and how to maximize?

- **Disciplinary lines are blurred**. Challenge with smart cities is that companies keep coming to us saying this disruptive technologies means this is a brand new industry. It's not its own discipline.
- **Students have cutting-edge knowledge**. Having students working with companies makes them already marketable as they're already a finite resource—no one before them has this experience since it is all new. As seen in CMU with deployment partner projects.
- **Terminology**. "ITS" is already transforming to "Smart Cities." We use the term "Smart Cities" for our class.
- **ITS is much more than engineering**. Game changers like Uber, but these are not civil engineers. We've heard from civil engineering professors, this is why we are with this group.

What Are the Gaps?

Through discussion over both days of the workshop, the participants identified and described unmet educational needs as well as available resources. Out of this process, gaps were identified and are listed in the table below. The biggest gap identified was in communication, with two components:

1. Students' communication skills with ITS content—the ability to deliver the proper level of technical detail to a given audience and to clearly communicate big picture ideas, purpose, and value on ITS topics
2. The ITS PCB Program and partners' communication—the ability to reach the proper audience with its ITS materials, as in those who would be interested but do not know this information exists or where to find it

Several other gaps were recognized as follows, and specific action items will be described further in the next section.

Current State	Future State	Factors	Actions to Address Gaps
Students are lacking communication skills in presenting technical info to varied audiences	Students will have opportunities to further their communication skills	Students take STEM courses in which communication skills are not emphasized	Offer activities to increase soft skills, especially communication
ITS PCB Program and Partners are not reaching all of target audience; many of those who could use the resources and would be interested, do not know about them	Educators in ITS topics will know where to go to find particular training materials to suit their teaching needs/ students' learning needs	Because ITS deals with emerging technologies, resources and those who seek them have less established channels	ITS PCB Program will work with TWCs and universities to spread word about available products and resources ITS PCB Program will seek out new channels
Innovative solutions to unprecedented challenges are lacking in the ITS workforce	Critical thinking and creative problem solving will be emphasized as part of the necessary skill set for students entering the ITS workforce	Students in STEM programs are not trained to think outside of conventional solutions to engineering problems	ITS PCB Program and partners to create initiatives that can involve students' critical thinking skills Professors may encourage students to do non-STEM or interdisciplinary coursework
Students do not have enough experience in the field when they start on the job	Students will have more knowledge of how ITS systems work in the field	Students are not required to do an internship or field work, and this is not taught in courses	Explore methods for students to get field experience as part of their education
Younger students do not have enough awareness of ITS to even know they may be interested in this field	Young university students will be more aware of ITS so that they can know if it is a good fit for them to pursue	Few universities cover ITS topics in survey courses and being interdisciplinary, it is hard to reach all the right potential students	Professors will explore ways of integrating ITS topics enough to pique students' interest
Students in various majors do not know how ITS is related to their field of study	Students in all related disciplines will understand how ITS relates to what they do	ITS spans many disciplines and there is no one channel that students follow to enter the ITS workforce	Explore ways to integrate ITS topics into students' education besides civil engineers
Young engineers either do not seek out in the first place, or leave public sector jobs for the private sector as soon as they have the valuable skills to do so	More young people in the workforce will have exposure to public sector work such that many will find it is a good fit for them and want to stay	Students do not have enough opportunities to understand first-hand what it's like to work in the public sector in ITS	Offer opportunities for students to know more about working in the public sector, such as internships with state DOTs, guest speakers, and field trips
Young ITS engineers are not familiar with knowledge of established standards, terminology, frameworks, processes, & approaches for the design, operation, & maintenance of ITS systems	Students will have more opportunity to learn about and apply this knowledge so that they are equipped when they enter the workforce	There are not established methods to teach this as ITS needs are constantly changing. It has been learned on the job but is needed when young engineers start on the job.	Offer opportunities for students in ITS to learn more of this practical knowledge in addition to theory

Current State	Future State	Factors	Actions to Address Gaps
Young ITS engineers do not have a solid understanding of all phases of the process, such as business development, planning, procurement, and oversight	Young ITS engineers will have better awareness of this when they start on the job, such that they are not starting from scratch	This is not taught in courses and there are few opportunities for students to obtain this knowledge	Explore opportunities for students to acquire more practical knowledge such as through internships or other field experiences
Students, educators, and practitioners do not well-articulate the economic benefits of ITS, such that new ITS engineers are not able to promote it from an economic standpoint in cash-strapped agencies	All should be able to understand and demonstrate with hard data the economic benefits of ITS rather than only costs and theoretical benefits	Focus has been more on the flashy side of ITS, the costs, and theoretical benefits	Explore methods to help students better understand and articulate economic benefits of ITS so that they are better prepared to demonstrate this when they enter the workforce
Educators and practitioners do not well-understand millennials career paths	Educators and public sector employers will be able to adapt more to the young workforce's needs and expectations	Career paths have changed dramatically in the last few decades and public sector employers have not caught up to understanding how to adapt	Explore ways for educators and practitioners to understand and better prepare to make the most of millennials in the workforce, through understanding of each step of career paths

Action Items

For Universities

- **Use math and problem solving in coursework**. Need to use math to make students interested in the class and in engineering—50/50 essay and math. For example CCTV camera installation (field of view, etc.), dynamic message signs (letter size, field of view). Start thinking about each area of ITS and the problems to solve. Travel time case study has a problem in it, which the students gravitate toward. For example, show under what conditions adaptive signal control is effective—students can say "benefit is 3 minutes per vehicle" or such. This is much more effective and interesting to students than just a lecture presentation.
- **Teach on how to convey information to various audiences**. What type of information needs to be communicated to which audience? How do you convey it? Need to learn how to convey to very technical audiences as well as make technical information palatable to laypersons and policymakers.
- **Problem sets**. Case studies take a long time, so a shorter tool like a homework problem set could be useful.
- **Google Group.** Is this still something professors would like to pursue? ITE also had database to do this and no one was using it. This is different than curriculum website which is more for information rather than coursework sharing. The Google group was being used by universities but then communication waned.
- **Scenarios**. Who do you talk to and what do you tell them? Would this be an interactive module?

For ITS America

- **Engagement.** Do more with university faculty and student chapters. Engagement with faculty could help form student chapters.
- **Cost**. Look at fees and accessibility to membership and annual meetings. ITS America Membership—$1400 fee for ITS America is a barrier.
  - o   ITS America is looking at various strategies to make it more accessible.
- **Collaboration**. Do more with NOCoE and possibly other groups.

For ITE

- **Engage Student Chapters**. ITE members could go out to student chapter meetings.

For ITS PCB Program

- **Tech transfer**. Plan T2 activities for existing ITSPCB Products.

- **Explore more channels**. Talk at CUTC meetings, through existing email blasts, work with universities and TWCs to find best channel for building professional capacity among students.
- **CUTC Meeting connection**. PCB program (Michelle) can bring materials to CUTC meeting at TRB in January.

For All/Other/Combination
- **Communications Case Study**. Communications move so fast. Ethernet, fiber optics, wireless, how data goes to TMC, could be a course in CV.
  - CITE course has been updated, so check if it suits. If not, tell us what it's missing. CITE telecommunications courses. V2V issues, policies, legal issues, etc.
  - Check T3 AV webinar series
- **One-pagers**. Could have a couple of pages on each topic—system engineering, AV, CV, etc. Professors don't have time to filter through all resources to find what they need, and often don't know what resources exist or remember where to look. Would be helpful to find a way to make some overview of resources easily available.
- **Webinars**. Purpose and target audience. Cannot always hit correct audience but we try to be specific.
- **Course at annual meeting**. Noblis does courses at annual meetings and they try to fit them within the theme, but never know what audience will be. For standards training, we tell what the prerequisites are so people can know what to expect and if it's suitable for them.
- **Define competencies**. Booz Allen has 16 different competencies. Everyone should be using the same categories for consistency, at least on technical side of how you define who audience and stakeholders are.
- **ITS trainings for State DOTs**. State DOTs have training programs but are more along the lines of flaggers, work zones, etc. not so much ITS stuff.
- **Partner with AASHTO**. AASHTO, ITE, Federal Highways, and ITSA, are partners in the NOCoE—Operations Council—try with Patrick now there to be more collaborative. We need these entities to come together for the benefit of the entire ITS community. Must be a consortium and priority that they all work together. A consortium driven by these three groups (ITE, ITSA, FHWA) is the goal, to bring them together under operations, TSMO, etc. Noblis hopes to work with AASHTO but needs to make this connection. They've been a hard partner to bring to table, but we try.
- **TWCs continue to make connections**. TWCs are working with HRs in different states. We've tried to work with training managers at state DOTs. TWCs could make connections with DOT training managers—just opening a dialogue about TSMO, operations, efficient government, efficient operations, etc. Universities could also help with some training. PCB program has not been able to. Role of regional centers is to connect, not to develop.
- **Committees**. AASHTO has standing committees (8-10) and subcommittees. Every state DOT can have a seat on these committees and subcommittees. National transportation training directors are now part of AASHTO. State DOTs are interested in traffic management. Trying to learn about cutting edge stuff but the center of knowledge will be in various aspects.
- **Find the right contact at State DOTs.** Traffic manager vs. training director--what is best approach to involve state DOTs? Probably traffic manager contacts will be primary. Training directors for state DOTs do soft skill programs—understand how this works in state DOTs how training director can get to traffic manager, or go directly to traffic manager. Going to training managers, they have budget and could prioritize and can work across their agency to know what training needs are. Traffic manager will know training needs for his group, and training director can facilitate.
- **Form joint student chapters**. Possibility to join student chapters of several organizations.
  - **Synergize**. Opportunity for students and synergy with the various companies—ITE, ITSA, WTS. They are different but have some overlapping interests that could be maximized. ITE, ASCE, ITSA, WTS—sit down together and say "what are our interests and what is in students' best interest?"
  - **National level coordination**. What is education and message to get to students? Some organizations may be stronger at some universities and will not want to give it up, so joining chapters must be judicious.
  - **Consider students' interest in these organizations**. Students care about connections—to employers, mentors, experiences. Can be affiliated with many organizations.
- **Host Competitions.**
  - Students are attracted by competitions—ITE's traffic bowl, etc.
  - Shark Tank—with real problem from State DOT and money behind it to deploy. Teaches communications

and many other skills. Students love puzzles, challenges, problem-solving, and will be excited about it.
- Competition awards—get to meet organizations, people providing money will give visibility, access to resources, etc.
- Even students that don't win get access to resources to make pitches and business plans better.
- Students peer review each other's pitches in class on content, delivery, and presentation. They do it over twitter and tell their friends who aren't even in the class. There is a lot of space for increased visibility.

Closing

Looking Ahead

After drawing up a list of action items, the participants were all thanked for their attendance and contribution. The workshop stimulated thoughtful discussion, broadened understanding, and resulted in promising ideas to pursue. The ITS PCB Program aims to be responsive to the needs of professors, students, and the workforce, by constantly adapting materials and creating new initiatives or collaborations to meet the need. As such, gathering input and sharing available resources in a forum such as this has proven to be a worthwhile way to maximize 36efficacy for all involved. The Workshop included both new and returning participants in the hopes of bringing both wisdom and fresh perspectives. The combination of professors, state DOT representatives, and those from professional organizations was useful in examining the needs in the workforce and how students in today's university programs can be better prepared to meet those needs, especially in public agencies. Needs and gaps in students' knowledge base and skill sets were articulated well by the group; the resulting list was used to brainstorm ways to fill these gaps.

Based on input from the 4th University Workshop, the ITS PCB Programs recognizes the interdisciplinary nature of ITS and the importance of reaching out to new audiences. Convening educators outside of civil engineering, and meeting the needs of students and educators in community colleges and technical schools will help to glimpse a wider picture of the ITS workforce and where it's headed. The ITS PCB Program would also like to improve its resources for professors by creating materials on new topics and making sure products are easy to adapt into existing curricula. Several tangible next steps were identified for the ITS PCB Program, including:

- Host a 5th ITS University Workshop focused on planning programs
- Host the 1st Community College ITS Workshop in late spring/early summer of 2017
- Develop more case studies
- Develop mini-slide presentations (library) on a variety of ITS CV/AV topics that professors can download and use with their existing course materials
- Continue and refine T3e webinar series
- Host a student competition with ITSA
- Develop and publish the ITS curriculum resources website for universities