Center for Integrated Asset Management for Multi-modal Transportation Infrastructure Systems: Region 3 University Transportation Center

CIAMTIS
U.S. DOT Region 3 University Transportation Center

Technology Transfer Plan

Background

The United States Department of Transportation (USDOT) defines technology transfer (T2) as the "process by which the transportation community receives and applies the results of research." (USDOT, 2018) Cuddy et al. (2016) identify a process by which T2 practices can be integrated into the research process to benefit the stakeholders in the transportation profession. This process is shown in Figure 1. The research and development process follows two steps: (1) defining the research project need and (2) carrying out the research. The T2 process occurs in parallel, and also involves two steps: (1) creating the T2 plan and stakeholder engagement, and (2) securing the funds to execute and manage implementation. When the research and T2 processes are integrated, the research outcomes are readily adopted by the transportation community.

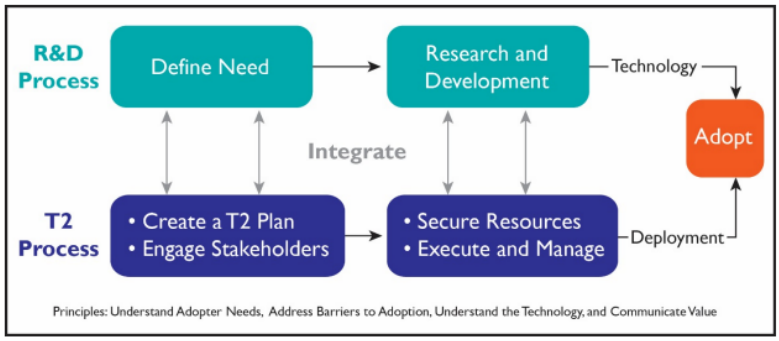

Figure 1. Integrating Technology Transfer into the Research Process (Cuddy 2016).

Successful technology transfer within CIAMTIS starts with engaging the stakeholders and potential adopters of research outcomes before commencing the research projects. The center's advisory board, which is composed of leaders from state transportation agencies and industry in the mid-Atlantic region, establishes the research agenda annually, in accordance with regional infrastructure needs and the Center's strategic thrust areas. Individual research proposals are reviewed in consideration of the research needs. Each awarded research project will be assigned a T2 project advocate, who will

work with the project PIs to identify T2 opportunities and assist with technology deployment. These steps are discussed further in this document.

Several planned center-wide T2 activities are described in the next section of this document. Within this section, each planned activity is summarized, along with the stakeholders, and a deployment timeline. Additional T2 activities will be undertaken by individual partners within the Center. The remaining sections of this memorandum describe the following elements of the technology transfer plan: (1) stakeholder involvement in research program activities, (2) process for assisting stakeholders in implementing and deploying research outputs, (3) commercialization process for research outputs, (4) collection and use of licensing revenues to provide further support for research and technology transfer, (5) dissemination of research results, (6) process for tracking and reporting research outputs, outcomes, and impacts, (7) process for increasing corporate research support, and (8) technology transfer goals and performance measures.

Proposed Center-wide Technology Transfer Activities

This section of the plan describes the proposed center-wide T2 activities planned by CIAMTIS consortium members.

Activity #1	**Mid-Atlantic Infrastructure Symposium**
Description	This annual center-wide symposium will bring together various stakeholders to disseminate the Center's research, enhance collaboration among participants, promote research implementation and technology transfer, and facilitate connections between students and transportation-industry employers via a career fair. The first event will be planned as a two-day activity with concurrent technical sessions, and will include presentations on each of the Center's three strategic thrust areas (application of innovative materials and technologies, condition assessment and health monitoring, and infrastructure management and innovative financing).
Stakeholders	Researchers, undergraduate and graduate students, state and local transportation agency professionals, engineering consulting firms, contractors, and materials and equipment suppliers.
Timeline/Frequency	Annually, beginning in 2019. Symposium will be rotated among CIAMTIS partners within mid-Atlantic region.

Activity #2	**Infrastructure Demonstration Day**
Description	During the Mid-Atlantic Infrastructure Symposium, students involved in CIAMTIS activities will perform demonstrations of the Center's research products, such as new materials, practices, test methods, technologies, software, and other innovations.
Stakeholders	Researchers, undergraduate and graduate students, state and local transportation agency professionals, engineering consulting firms, contractors, and materials and equipment suppliers.
Timeline/Frequency	Annually, beginning in 2019. Held during the annual symposium, which will be rotated among CIAMTIS universities within mid-Atlantic region.

Activity #3	**Annual Interuniversity Symposium on Infrastructure Management (AISIM)**
Description	This one-day symposium organized and run by graduate students has been highly effective in encouraging collaboration and networking among graduate students. We will leverage the existing structure to enhance these activities for the CIAMTIS consortium graduate students who are interested in transportation infrastructure management. Students will use the symposium to exchange ideas and technical information related to their research, as well as a networking opportunity to interact with regional leaders.
Stakeholders	Researchers, undergraduate and graduate students, state and local transportation agency professionals, and engineering consulting firms.
Timeline/Frequency	Annually, beginning in 2020. In 2019 students will participate in AISIM (slated to occur at Rutgers in May). In 2020 they will organize AISIM and in future years either participate in AISIM or organize AISIM-Region 3 for consortium graduate students, rotated among consortium universities within mid-Atlantic region.

Activity #4	**Infrastructure Webinar Series and Training Courses**
Description	Bimonthly webinars will disseminate the latest research products and technologies related to infrastructure asset management. One professional development hour (PDH) will be offered to participants for each webinar. CIAMTIS

	universities will also offer a variety of seminars, workshops, and training courses to help educate practitioners with the latest infrastructure-related technologies, design practices, and research products.
Stakeholders	The target audience is engineering professionals from the mid-Atlantic region and beyond.
Timeline/Frequency	Will begin in January 2019 and be held bi-monthly through Center period of performance.

Activity #5	**Technical Briefs**
Description	Research project principal investigators will prepare a two-page technical brief of research project findings and implementation activities, which will be posted on the CIAMTIS website. The technical brief will include background information, methodology, results, and plans and recommendations for implementation of the research into practice.
Stakeholders	The target audience will be state and local transportation agencies, contractors, and material suppliers in the mid-Atlantic region.
Timeline/Frequency	All final research reports will include a two-page technical brief.

Stakeholder Involvement in Research Program Activities

Stakeholders for CIAMTIS include state and local transportation agencies, contractors, materials suppliers, engineering consulting firms, and undergraduate and graduate students. A summary of how the stakeholders will be involved in the CIAMTIS research program activities is provided below:

- Research projects in CIAMTIS will have a technology transfer advocate from a state or local transportation agency within the region. For example, research projects being undertaken by faculty at Penn State will include a technical monitor from the Pennsylvania Department of Transportation (PennDOT). Collaborative research projects will also have a technology transfer advocate, who will be identified by the research team. The advocate will work with the project Principal Investigator (PI) to identify and execute T2 activities for each research project undertaken in the Center – candidate T2 activities will be included in research proposals. Example T2 elements may include, but not be limited to, the five activities identified above.

- Research projects in CIAMTIS will involve either undergraduate or graduate students, or both. The students will have opportunities to hold prominent roles in T2 activities #1 through #3 above – they will be featured speakers at regional symposia and demonstration days. Participants in the regional symposia and demonstration days will include representatives from state and local transportation agencies, engineering consulting firms, materials suppliers, and contractors, who will be direct recipients of the technology transfer through presentation and field and laboratory demonstrations.
- The CIAMTIS advisory board members consist of executive and management level representatives from state transportation agencies, engineering consulting firms, and a national railroad company. These individuals will work with the CIAMTIS leadership throughout the Center's period of performance to identify opportunities to transfer T2 activities within their respective agencies and the broader stakeholder group within the region.

Process for Assisting Stakeholders in Implementing and Deploying Research

The process for assisting stakeholders in implementing and deploying research outputs is shown in Figure 2. The first step involves defining the **T2 adopter needs**, which will be done by the advisory board when developing the annual call for research topics, so that all research proposals contain T2 ideas that are of interest to the CIAMTIS stakeholders. During the project, the T2 project monitor, who will be assigned to each project, will work with the research project Principal Investigator to define T2 opportunities for the project. The T2 advocate will be a member of a state or local transportation agency within the mid-Atlantic region.

The second step in the T2 process is **understanding the technology** to be adopted. Prior to each research project, the Principal Investigator and T2 monitor will work collaboratively to define the technology objectives and metrics to measure the performance of the technology. During the project, technology development will be monitored based on the pre-defined performance measures, and barriers to T2 implementation will be identified by the project Principal Investigator and T2 monitor.

Once the barriers to implementation have been defined, the Principal Investigator and T2 monitor will seek opportunities to **manage or mitigate barriers to adopting** the technology. After the project is concluded, the Principal Investigator will, if necessary, customize the technology in order for it to be implemented in practice.

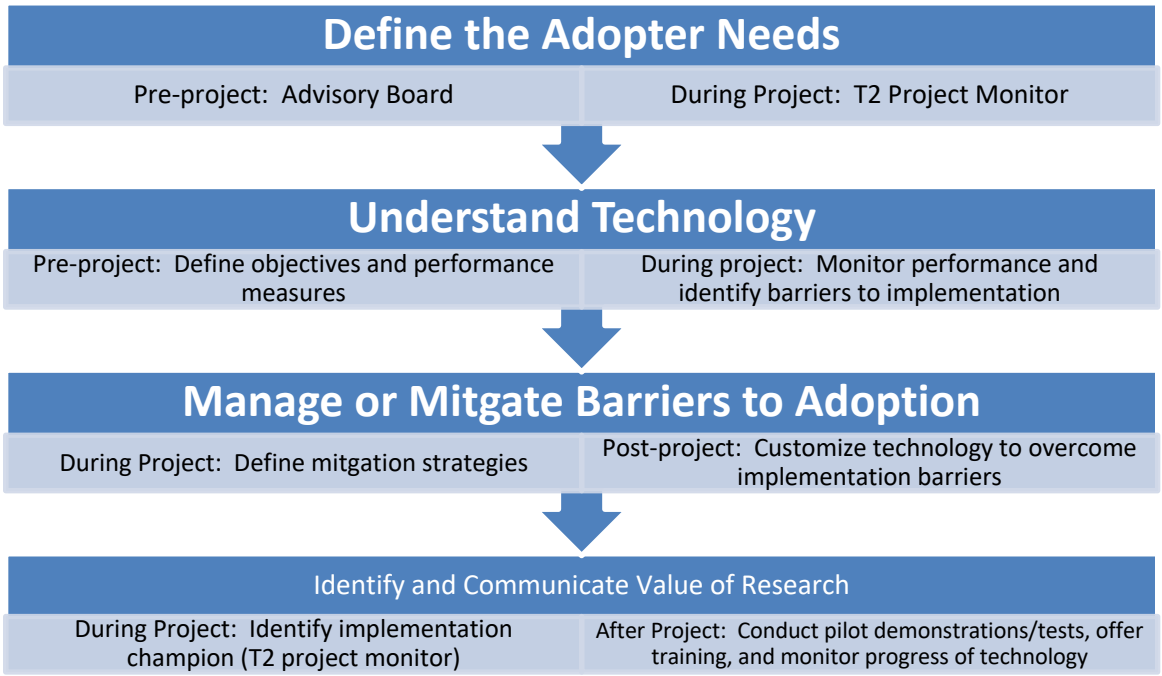

Figure 2. Research Deployment Process.

The final step in the T2 adoption process is **identifying and communicating the value of the research** to the stakeholder community. During each research project, the Principal Investigator and T2 monitor will identify a champion to implement the technology. Champions may come from the research team, T2 monitor, state or local transportation agencies, engineering consulting firms, suppliers, or contractors. Once the implementation champion has been identified, this (these) individual(s) will work with CIAMTIS staff (Director, Associate Director, or Education Program Coordinator) to identify opportunities to demonstrate the technology via standardization, field implementation, or pilot projects. This will include engaging with the FHWA regional offices and the State Transportation Innovation Council (STIC) in each state to seek support and identify opportunities for deployment and implementation of research products. This will also include offering workshops, training courses, or presentations; e.g., in collaboration with the Local Technical Assistant Programs (LTAP) in the region, in addition to venues discussed earlier. The CIAMTIS staff will collect information about who receives the technology and develop "information sheets" on the effectiveness of the technology. These informational briefs will be included in the CIAMTIS newsletter, which will be distributed to stakeholders within the mid-Atlantic region.

Commercialization Process for Research Outputs

Each partner institution in the CIAMTIS consortium has an Office of Technology Management that helps faculty protect intellectual property and commercialize new products and services by transferring the technologies to existing and start-up companies. The process recommended to commercialize research outputs at Penn State University is shown in Figure 3 – all other partner institutions likely follow a similar process.

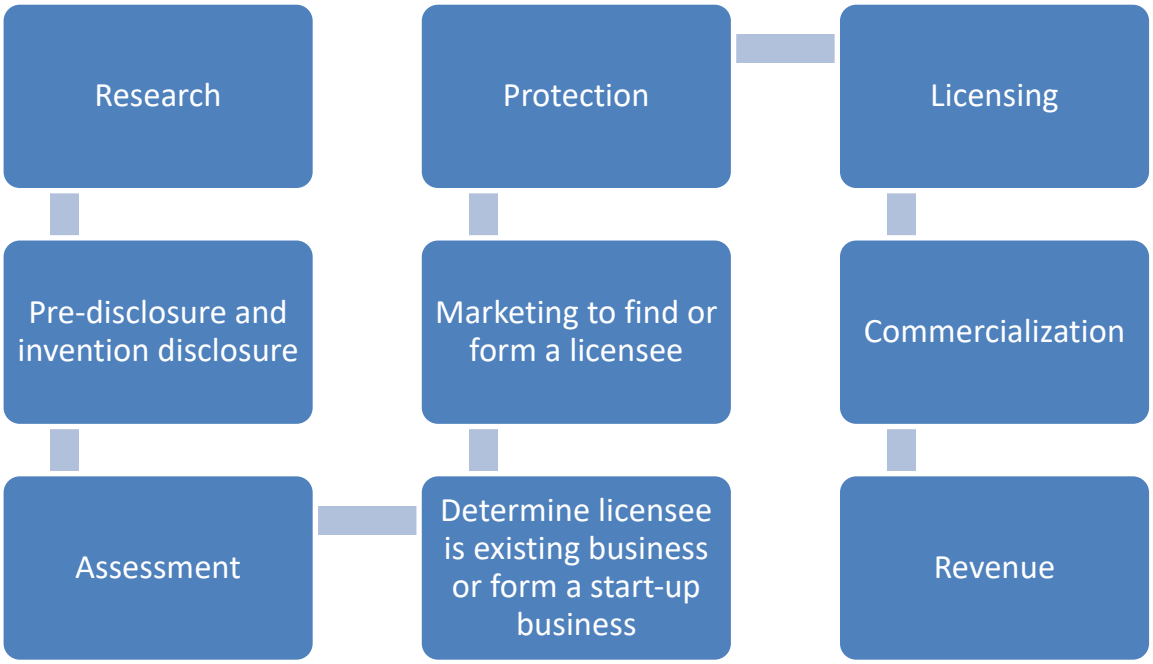

Figure 3. Research Commercialization Process
(adapted from "An Inventor's Guide to Technology Transfer at Penn State University").

Each step of the commercialization process is described below:

1. **Research:** Inventions from research include any process, machine, composition of matter, or new or useful improvement of a process, machine, or composition of matter.
2. **Pre-disclosure and Invention Disclosure:** If the research results in a possible invention, the Principal Investigator will contact their institution's Office of Technology Management (OTM) to seek guidance with respect to the disclosure, evaluation, and protection processes. The Invention Disclosure includes a written notification from the Principal Investigator to the OTM to begin the formal T2 process. This information is confidential, but should provide detailed documentation of the invention for subsequent evaluation.

3. **Assessment:** The Principal Investigator will work with a technology licensing officer to review the invention disclosure, conduct patent searches, and perform a market evaluation of competitive technologies to determine the invention's commercialization potential.
4. **Protection:** If the invention is deemed to have market potential, the institution's OTM will file a patent application with the United States Patent Office and, if appropriate, international patent offices. Alternatively, other project methods, such as copyright, trademark, and confidential know-how will be considered by the institution's OTM. All patent rights and copyright documentation will be completed in collaboration with the UTC Grant Program manager.
5. **Marketing to Find or Form a Licensee:** The Principal Investigator and OTM will identify candidate companies with the necessary expertise and resources to market the invention. Alternatively, the Principal Investigator may decide that a start-up company is better suited market the invention.
6. **Start-up or Existing Business**: If a start-up company is the preferred path to commercialization, the OTM will work with the institution's entrepreneurial network to assist the Principal Investigator with planning and securing funding for the start-up company. If an existing business is well-suited to commercialize the invention, the OTM will seek licensees and identify a framework to commercialize the technology.
7. **Licensing**: A license agreement will be developed between the institution and a third party for financial and other benefits.
8. **Commercialization**: The licensee company will advance the technology and make other business investments to develop the product or service. The Principal Investigator may be involved in marketing, sales, training, or other product development during this stage of the process.
9. **Licensing Revenue**: Revenue received from the invention is distributed to the inventors, administrative units, and the institution. The current distribution used at Penn State is 40 percent of the revenue is returned to the inventor, 20 percent is returned to the administrative unit, and 40 percent is distributed to the Penn State Research Foundation.

Researchers wishing to commercialize technology or products resulting from CIAMTIS will also be assisted by Penn State's Small Business Development Center (SBDC). There are several entrepreneurship options available, including full-time business ownership, technology licensing agreements, and consulting. The SBDC also offers the following services to support commercialization:

- The *Research to Start-up* seminar, which includes a 90-minute overview of the business, technology, and intellectual property considerations to consider;

- Free one-on-one consulting with a business consultant with specialized training in technology commercialization;
- Additional seminar series focused on topics such as government contracting, Small Business Innovation Research (SBIR) grant opportunities, export trade development, marketing, and accounting;
- Assistance with business financing and business planning;
- Facilitated access to other economic development partners and opportunities.

In addition to the SBDC, CIAMTIS researchers will also have access to Ben Franklin Technology Partners, which provides start-up funding for potential tech-entrepreneurs and small manufacturers at the earliest stages of their concept development, and invests in innovative, entrepreneurial development programs that mentor and support emerging startups. UTC grant funds and professional staff time may be used to support the following opportunities and services in partnership with the Ben Franklin Partners:

- Stipends to assist with initial prototyping and customer discovery expenses as well as initial legal and accounting advice.
- Strategic planning and market research.
- Critical evaluation of business strengths and weaknesses, as well as advantages and potential threats in the market.
- Market research analysis of the industry, product, competition, market segments and potential customers.
- An Incubator Program also provides assistance with accounting practices, office procedures, and human resource planning and management.

Finally, Penn State's Fund for Innovation promotes the commercialization of promising ideas, which may lead to the creation of new companies. Funding from CIAMTIS may be used to help Principal Investigators develop a product or technology proof-of-concept or proof-of-relevance. Once these are established, Penn State may invest $50,000 to $100,000 to form the company and commercialize the idea. CIAMTIS staff are committed to working with industry partners (e.g., contractors and materials suppliers) and local and transportation agencies to expand new technologies and products throughout the region.

Collection and Use of Licensing Revenues to Provide Further Support for Research and Technology Transfer

Revenue from commercialization of an invention is split among the inventor, administrative unit, and the institution. At Penn State, CIAMTIS is housed within the Thomas D. Larson Pennsylvania Transportation Institute (LTI), which would receive 20

percent of the revenue in the event that an invention is commercialized. LTI is committed to re-investing all of these funds into subsequent CIAMTIS research and technology transfer activities undertaken by faculty and students at Penn State. These funds will be used as matching funds. The other CIAMTIS partners will develop their own re-investment plan for research and technology transfer activities associated with the UTC grant. If the revenue continues beyond the period of performance for the regional UTC, this revenue will be invested to allow continuing one or more of the center-wide T2 activities identified above (e.g., regional infrastructure symposium, demonstration days, or infrastructure webinar series).

All inventions and patents developed through CIAMTIS funds will be reported to USDOT using the iEdison system.

Dissemination of Research Results

Partners in the CIAMTIS consortium will undertake a variety of activities to disseminate research results. In addition to the institution-specific activities proposed by each partner, the following center-wide activities will be undertaken:

- Partner institutions will capitalize on our strong partnership with state transportation agencies in the region and engage the State Transportation Innovation Council (STIC) in each state as well as local agencies and FHWA regional offices to champion promising new technologies and accelerate their deployment through standardization, pilot demonstration projects, and related initiatives such as the Every Day Counts (EDC) and the Accelerated Innovation Deployment (AID) Demonstration Program. CIAMTIS research will likely produce outcomes that have the opportunity for transportation agencies to revise their standard practices, design guides, or materials and construction specifications. UTC funds may be used to help Principal Investigators work with transportation agencies, contractors, or materials suppliers update their practices, guides, or specifications.
- The annual Mid-Atlantic Infrastructure Symposium and Career Fair will provide an excellent opportunity for faculty and students to share their research results with state and local transportation agencies, engineers, contractors, and other stakeholders via presentations and workshops. This will facilitate information exchange and collaboration to utilize and implement research products in practice.
- Many CIAMTIS researchers are leaders in technical organizations, such as the Transportation Research Board and American Society of Civil Engineers. These researchers will collaborate with these organizations to provide technical assistance through sessions and workshops, leading research outcomes that are implemented into standards and practices.

- CIAMTIS faculty are active in publishing research results in high-impact journals and presenting at international, national, and local transportation conferences. The center will strongly encourage publications in peer-reviewed journals, conference proceedings, and trade magazines to share research results with the academic and professional communities. Examples of journals in which CIAMTIS faculty will be encouraged to publish their results include: ASCE Journal of Bridge Engineering, ASCE Journal of Composites for Construction, ASCE Journal of Construction Engineering and Management, ASCE Journal of Engineering Mechanics, ASCE Journal of Infrastructure Systems, ASCE Journal of Materials in Civil Engineering, Journal of Performance of Constructed Facilities, ASCE Journal of Structural Engineering, ASCE Journal of Transportation Engineering, Composite Structures, Computer Methods in Applied Mechanics and Engineering, Computational Mechanics, Cement and Concrete Research, and Journal of the Transportation Research Board. Examples of conferences and symposia that CIAMTIS faculty will be encouraged to attend include: Transportation Research Board Annual Meeting, ACI Semi-Annual Conventions, World of Asphalt Show and Conference, ASCE Structures Congress, ASCE International Conference on Computing in Civil Engineering, ASCE International Airfield and Highway Pavements Conference, and the International Conference on Sustainable Infrastructure.
- E-newsletter: CIAMTIS will publish and widely distribute a quarterly e-newsletter to broadly disseminate its research, education, outreach, and technology transfer activities. The newsletter will be distributed to all transportation infrastructure stakeholders in the region, including technical staff at state and local transportation agencies, FHWA (division offices), and contractors and consultants that offer transportation construction or maintenance services.
- Technical Briefs: Principal Investigators of funded projects will prepare a two-page technical brief of the research findings. The tech briefs will be posted on the Center's website and included in the e-newsletter. Each brief will include background information, methodology, results, and recommendations for implementation. The tech briefs will facilitate adoption of research outcomes in practice.
- Website and Social Media: The Center's website will feature information about the consortium (e.g., faculty members, expertise, facilities), descriptions of completed and current research projects and their products, links to project quarterly and final reports, research RFPs, and links to the Center's e-newsletters and semi-annual progress reports to the USDOT. The website will also include announcements on student and faculty accomplishments and previous and upcoming education, outreach, and T2 activities. In addition, the Center's communication staff at Penn State will develop a social media campaign, via Facebook and Twitter, to announce Center activities, such as technology transfer offerings, publication releases, meetings, and conferences.

- Participation in the Council of University Transportation Centers, American Association of State Highway and Transportation Officials, American Society for Testing and Materials, and American Road and Transportation Builders Association meetings.
- Hosting tours of laboratory and computer facilities by transportation agencies and industry partners at each CIAMTIS partner institution.
- Presentations to student organizations at CIAMTIS partner institutions, such as the American Society of Civil Engineers, American Concrete Institute, Engineers without Borders, and Bridges to Prosperity.

Process for Tracking and Reporting Research Outputs, Outcomes, and Impacts

The CIAMTIS Director, Associate Director, and Educational Program Manager will be responsible for tracking and reporting the output, outcomes, and impacts resulting from the Center's research activities. CIAMTIS will ask all of the points of contact (technical steering committee members) from each partner institution to work with their researchers to populate a spreadsheet of the research output, outcomes, and impacts shown in Table 1. Penn State is working with an IT team to determine if the spreadsheet tool can be converted into a "real-time" project tracking database that can be shared with the other partners in the consortium.

The research thrusts for CIAMTIS are: (1) application of innovative materials and technologies, (2) condition assessment and health monitoring, and (3) infrastructure management and innovative financing. Efforts will be made to document how each of these performance metrics "map" to the thrust areas in order to identify the research impact for each focus area of the Center. The assessment measures shown in Table 1 will be collected annually by the Center.

In addition to tracking research output, outcomes and impacts in a spreadsheet, the CIAMTIS website will also serve as a "real-time" performance monitoring system. Under the "News & Events" tab, short stories, press releases, and research accomplishments will be published. A calendar of events will also be maintained in this tab. The social media campaign (Facebook and Twitter) accounts will be connected to the webpage, as will the e-mail newsletter. Analytics associated with social media (e.g., Twitter followers, Google Analytics) can be used to compile information regarding widespread dissemination of CIAMTIS activities.

Table 1. Research Performance Metrics.

Output, Outcome, or Impact	Performance Measure	Target
Output #1	Annual number of journal publications	30
Output #2	Annual number of conference presentations	40
Outcome #1	Annual number of times research changes a standard practice, guideline, or specification	2
Outcome #2	Annual number of media stories referencing CIAMTIS research, faculty, or students	12
Impact #1	Percentage of research projects that extend infrastructure asset life by 10%	20%
Impact #2	Percentage of research projects that reduce repair, maintenance, and rehabilitation costs by 10%	20%

Process for Increasing Corporate Research Support

Infrastructure stakeholders throughout the region will assemble and share ideas related to the three thrust areas of CIAMTIS during the annual Mid-Atlantic Infrastructure Symposium. The symposium will be delivered during the non-construction season to maximize participation from transportation agencies, material suppliers, contractors, rail companies, and others within the region. The Infrastructure Demonstration Days that accompanies the symposium will also offer opportunities for CIAMTIS researchers to learn about new materials and products from industry, and to showcase how research results may be implemented in practice. This interaction with corporations will afford opportunities to identify academic-industry partnerships for research. CIAMTIS leadership will encourage corporate research support to leverage UTC investments. In addition, research PIs will be encouraged to establish strong working relationships with the industry and to seek corporate funding as matching for UTC dollars.

Other processes that CIAMTIS will undertake to increase corporate research include T2, activities such as the infrastructure webinar series, as well as the technical briefs. The webinar series will include a corporate membership fee for members of the corporation to earn professional development in support of job growth and certification (e.g., Professional Engineering licensure). A portion of the fee collected for these webinars will be re-invested into CIAMTIS for use as matching funds on research projects.

Outreach activities, such as social media and the e-newsletter, will also be used to foster external collaboration with corporations.

Technology Transfer Goals and Performance Measures

The principal technology transfer goals of CIAMTIS are to:

1. Develop research products that have measureable transportation infrastructure and asset management benefits to the stakeholders in the region.
2. Increase the number of undergraduate and graduate students who, through research and educational activities, develop the technical skills necessary to positively impact the nation's transportation infrastructure systems.
3. Improve the ability of state and local transportation agencies to efficiently allocate funds to enhance the safety and durability of the regional transportation infrastructure.

Table 2 lists the performance metrics that will be collected to assess the effectiveness of the Center's technology transfer activities. The performance targets for each metric are also shown in Table 2.

Table 2. Performance Metrics for CIAMTIS Technology Transfer Activities

Performance Metric	Assessment Measure	Performance Targets
Partnership with Private and Public Entities	✓ Number of technologies advanced to State Transportation Innovation Councils (STIC) in each state or nominated for Every Day Counts (EDC) and Accelerated Innovation Deployment (AID) programs. ✓ Number of adopted technologies or programs.	✓ One STIC technology innovation annually. ✓ One adopted technology or program annually.
Patents and Commercialization	✓ Number of invention disclosures, patents, and copyright applications. ✓ Number of license agreements.	✓ One invention disclosure, patent, or copyright application annually. ✓ One license agreement annually.
Publications and Presentations	Number of publications and presentations per project and per thrust area.	One publication and presentation per project per year.
Information Exchange	Number of website visitors, news reports, and tech-briefs.	500 website visitors annually, seven news reports annually, and seven technical briefs annually.
Continuing Education Courses	✓ Number of courses offered annually. ✓ Number of participants.	✓ Three continuing education courses offered annually with at least 25 participants per course.
Number of students supported	✓ Number of undergraduate and graduate students supported annually by CIAMTIS	✓ Support at least 20 undergraduate and 20 graduate students annually.

References

An Inventor's Guide to Technology Transfer at Penn State University. Found at: https://www.research.psu.edu/sites/default/files/PSU-Inventors-Guide-to-Technology-Transfer_0.pdf

United States Department of Transportation (USDOT). What is Technology Transfer? Found at: https://www.transportation.gov/research-and-technology/technology-transfer

Cuddy, M., D. LaFrance-Linden, A. Berthaume, and S. Navarro. *Building a Foundation for Effective Technology Transfer through Integration with the Research Process.* Report No. DOT-VNTSC-OSTR-16-02, U.S. Department of Transportation, Washington, DC, 2016.