Committee for Intelligent Construction Systems and Technology: Program Review Letter Report: November 26, 2013

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0 pages | 8.5 x 11 | PAPERBACK

ISBN 978-0-309-43380-8 | DOI 10.17226/22461

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Committee for Intelligent Construction Systems and Technology

TRB TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES

November 26, 2013

Mr. Victor Mendez
Administrator
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1200 New Jersey Avenue, SE, Room E85-113
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Dear Mr. Mendez:

This is the second letter report of the Transportation Research Board's (TRB's) Committee for Intelligent Construction Systems and Technologies: Program Review. The committee was established at the request of the Federal Highway Administration (FHWA) to provide strategic advice and guidance to FHWA concerning the conduct of its Intelligent Construction Systems and Technologies (ICST) program. The committee membership has been drawn from the senior professional levels of state and county highway agencies, private industry, and academia. The committee's collective expertise covers a broad spectrum of scientific and engineering disciplines applied in highway infrastructure construction and management. Three members from the private sector have been added to strengthen the committee's field expertise and experience in highway infrastructure construction and contracting. A roster of the committee is provided as Attachment 1.

The committee held its second meeting on October 3–4, 2013, in Washington, D.C. Fourteen of the 15 members were in attendance. This letter report presents the committee's assessment of the program as developed in a closed session at the end of the meeting and completed through correspondence. As before, the report was reviewed by an independent group of peers in accordance with the policies and procedures of the National Research Council. The assessment and recommendations of this report represent the committee's best collective judgment and are based on the information provided at the meeting.

ICST Program

The committee appreciates FHWA's efforts to clarify what constitutes the ICST program in response to the question raised in the first letter report and concurs with the new definition:

> Intelligent Construction Systems and Technologies have the ability to collect, store, analyze, and process information and to make and execute an action or decision that results in quality construction. This is in conjunction with components, processes, and software that assist in a more effective system of construction.

The committee recommends that each of the technologies listed in the original ICST strategic roadmap be filtered through this definition to determine whether it is included in or excluded

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from the program. The relationship of the ICST program to other FHWA efforts, such as the Every Day Counts (EDC) initiative, remains unclear. The committee is taking the tentative position that any technology deemed ICST and listed in the ICST strategic roadmap would fall under the committee's purview regardless of whether that technology is included in other FHWA initiatives. The committee needs to know whether FHWA concurs with this position.

The committee's first letter report encouraged FHWA to develop a framework for determining new projects, with selection based on how a project relates to ICST objectives and is coordinated with other activities. The committee reiterates this advice, since the presentations did not make clear how projects were selected or how decisions concerning implementation activities were made. To achieve success with a limited budget, FHWA needs to institute a formal transparent project selection process based on its global ICST strategy. A similar decision process for identifying the most beneficial implementation activities is also needed.

ICST Strategic Roadmap

In accordance with the recommendations of the committee's first letter report, FHWA is working to refine the ICST strategic roadmap (referred to at the meeting as the "tablecloth") to focus on technologies clearly within the definition of intelligent construction. The subject matter technologies in the roadmap have been reduced from seven to six: construction and project management, earthworks, pavements, structures, surveying, and traffic and safety. Potential technologies under each of these subjects have been prioritized and summarized in a table that was shown to the committee in draft form. More than half of the entries in the table were not funded; therefore, their relevance to the committee's work needs to be clarified.

FHWA seeks the committee's guidance on technologies that cut across subject areas as a means of achieving more with less. The committee suggests that FHWA create a matrix to supplement the table, with crosscutting technologies being identified in columns and individual technologies being identified in rows. For example, three-dimensional (3D), 4D, 5D, and 6D technologies have potential benefits across all six subject matter technologies. This process will help identify which technologies have the most potential for cross-subject benefits.

FHWA needs to determine which of the 150 technologies included in the strategic roadmap it is in the best position for advancing. Some technologies may be better suited for advancement by private industry than by FHWA. After prioritization of the technologies for advancement, FHWA needs to prepare a summary statement for each of those technologies. The statement should contain a brief description of the technology, its potential benefits, and why it is included in or excluded from the current list of applicable technologies. The statements will help the committee and others understand FHWA's results and help the committee in its guidance role. The statements might contain brief references to connections with the Strategic Highway Research Program 2, EDC, and other programs to help show interrelations. The committee also suggests that FHWA consider preparing something like a Gantt chart illustrating the various technologies included in the program and the timeline of the implementation process as currently planned. Such a chart could show how the pieces fit together and provide metrics for gauging progress toward the goals.

Intelligent Compaction Implementation

The committee approves FHWA's efforts on intelligent compaction (IC) implementation. Activities being conducted or planned for workshops, training, technical briefs, specification development, and research will continue to move this initiative forward. The committee supports creation of the IC Technical Support Service Center (TSSC). The committee recommends that the TSSC contractor be tasked with user follow-up to identify how the information or assistance was used and to track successes or lessons learned. User comments may lead to the identification of new research or development needs.

One of the obstacles to IC implementation by users (both contractors and owners) is cost. The committee suggests that FHWA quantify the benefits to various target audiences. For example, FHWA could demonstrate the impact of IC on service life of pavements. The committee also suggests that FHWA update the EDC implementation plan as goals are met and strategies are revised or further defined. As stated in the committee's first letter report, the implementation plan could be strengthened by clarifying the following:

1. Items considered to have the highest priority and items that need to be funded first,
2. Estimated cost for each activity, and
3. Expected duration for each activity.

A flowchart, or a Gantt chart as suggested in the previous section, might help in showing how all the activities fit together along with their order of priority and timeline for their implementation.

The committee reiterates its earlier recommendation that FHWA consider related scanning technologies that would enhance and complement the IC technology, including the paver-mounted infrared temperature bar and ground penetrating radar.

The committee learned at the meeting that the American Association of State Highway and Transportation Officials (AASHTO) is developing a specification on IC. The committee recommends that FHWA collaborate in this effort. FHWA and AASHTO might consider providing guidance to states on how to encourage (rather than mandate) capital investment in IC technologies by contractors. The committee also recommends that FHWA collaborate in the pooled-fund study TPF-5(233), Technology Transfer Intelligent Compaction Consortium, which currently has nine partner states.

Civil Integrated Management

FHWA defined civil integrated management (CIM) at the committee's first meeting as "intelligent construction + partnering." The committee endorsed this definition at that time; however, on the basis of information available now, the committee no longer believes the definition to be accurate. The committee notes that FHWA presents a new definition of CIM at workshops that reads as follows:

> CIM is the collection, organization, and managed accessibility to accurate data and information related to a highway facility. The concept may be used by all affected

parties for a wide range of purposes, including planning, environmental assessment, surveying, construction, maintenance, asset management, and risk assessment.

The committee prefers this definition, since it characterizes the proper use of ICST for "fast, efficient, and safe delivery of projects" and does not require partnering in its scope. Partnering, according to the General Services Administration, is a formal management process designed to enable cooperation among all stakeholders in the delivery of capital projects and to mitigate litigation claims among the participants (http://www.gsa.gov/portal/content/100822). However, the new definition of CIM mentions "organization" and "managed accessibility" to data and information. The committee suggests that the CIM concept retain an emphasis on the human elements of collaboration and cooperation, without which such organization and accessibility would be less effective. Other human capital technologies and techniques, such as collaboration engineering and derivatives of the Tuckman model, may be similar to but distinct from partnering.

CIM itself is not a technology but rather a set of processes and objectives. Therefore, the new definition may lend itself to the framework that the committee had recommended in its first letter report. Although CIM is a process, it needs to be included with the list of technologies in the strategic roadmap. The committee recommends that the CIM concept be mentioned in these efforts and that all deployments of ICST program technologies be checked for compatibility with CIM. The ICST program technologies should be a part of the strategic framework that the committee had recommended in its first letter report and that FHWA has designated as CIM. The framework could be specific to agency functional areas as well as life-cycle stages of facilities designed, built, and operated with the use of ICST.

At the meeting, FHWA presented information about TRB's National Cooperative Highway Research Program Project 20-68A, Scan 13-02: Advances in Civil Integrated Management. In this domestic scan tour, the scan team will examine projects that utilize ICST program technologies and partnering to document best practices (ICST usage, project performance measures, successful partnering techniques, etc.). On the basis of information provided at the meeting, the committee recommends the following:

1. The scan should create objectives and outcomes that are based on the new definition of CIM noted above.
2. The scan team should examine the audit process for federal-aid contract administration in light of the CIM process and how the CIM process meets the requirements for auditing and record keeping required as part of federal-aid contract administration.
3. The scan team should document all aspects of information technology systems used in CIM (i.e., operating systems, file storage and backup, interoperability of data between software applications, and ties to other systems such as geographic information systems).

3D Engineered Models

3D models of transportation facilities are the building blocks for CIM and the incorporation of ICST technologies such as automated machine guidance and IC. 3D engineered models have the potential to manage a transportation facility at all stages from planning to operation. At the

meeting, FHWA presented technical briefs that highlighted 3D engineered models and provided information for agencies seeking education on the technology. The committee is pleased that FHWA has taken a leadership role in identifying progress in the use of 3D engineered models in the construction of highway facilities. State departments of transportation (DOT) and highway facility owners have the greatest potential for benefitting from the use of 3D engineered models in the long term while contractors and public also benefit from accelerated construction activities.

In several states, 3D engineered models are being used for construction in two or more projects, and these states have emerged as national leaders in this area. Several other states are either exploring or piloting the use of these models. FHWA's presentation was unclear with regard to the utilization of other add-ons to 3D design (4D, 5D, 6D, and XD) as well as for which lifecycle stages the model was to be utilized (pre/postconstruction, operations, maintenance, etc.).

The technical briefs provided insight into the use of 3D engineered models for construction. Since these models are an integral part of a CIM program and cut across several phases of the highway infrastructure life cycle, an assessment by the committee of progress with regard to various other phases in addition to the construction phase would be useful. The committee would like to see updated information on the following:

1. Status of 3D engineered models for design, construction, and infrastructure management;
2. Promotional and informational products for the use of 3D engineered models for facilities management;
3. Return-on-investment studies on the use of 3D engineered models from the early stages of civil infrastructure development;
4. Products for which FHWA and state DOTs have provided support for the use of 3D engineered models (especially to smaller contractors or to uninitiated agencies and contractors); and
5. Continued FHWA efforts to standardize data transfer language across platforms.

Accelerated Bridge Construction and System Technology Deployment

In the read-ahead material provided before the meeting, FHWA acknowledged the committee's suggestions that the agency expand its technical assistance and promotion to include a "bridge system move" suite of products and that it consider helping owners develop detailed specifications for the initial application of the technology in a state and performance-based specifications in subsequent applications. FHWA also acknowledged the suggestion that it collaborate in AASHTO's Technology Implementation Group (TIG) lead states team process and involve industry to increase implementation of the suite of available bridge system move products. While FHWA cited limited resources as a key challenge for technology deployment, it concurred that the TIG lead states model represented an opportunity for leveraging expertise and resources and noted its partnership with the Utah and Colorado DOTs in slide-in deployment efforts.

The committee was provided an update on FHWA's slide-in deployment activities, which are important for its EDC slide-in initiative. However, FHWA appears not to have broadened its efforts to include the suite of bridge system move products. Furthermore, what it has reported fails to focus

on intelligent construction monitoring and operational control of the propulsion method to position the structure correctly. In addition, intelligent construction is needed to ensure that the service life of the structure is not reduced by the dynamic forces that occur during the system move. The committee again recommends a broader focus on a suite of intelligent bridge system move products for accelerated bridge construction, including those for removal of existing bridges. The committee suggests that FHWA document lessons learned in completed bridge system move projects for use by bridge owners interested in this technology.

ICST-Related Research Under Way or Planned at FHWA

In its first letter report, the committee sought answers to several questions to help evaluate the effectiveness of FHWA's ICST-related research activities. The questions were concerned with the selection, review, and implementation of research projects as well as with their relevance to the ICST program. FHWA provided answers to these questions at the meeting. It offered to share quarterly reports on its research activities with the committee, which would be appreciated. The committee generally agreed that data sharing and integration across platforms and technologies remained a major challenge.

The committee suggests that research projects that fall under the ICST program be included in the "tablecloth" summary document being developed by FHWA's ICST group. This will help ensure that projects fit the mandate of the ICST program. For example, the high-speed deflection testing project may not be a good fit for the ICST program, since it is typically used for asset management, not construction. However, the committee recognizes that high speed deflection testing may be more widely used in the future for project level quality acceptance as part of a performance based specification.

The committee was informed that FHWA had advertised and awarded an ICST-related research project, Addressing Challenges in Intelligent Construction Systems and Technologies, before its second meeting. FHWA received only one proposal in response to its solicitation and awarded the contract to the proposing entity. The committee expresses concern that this solicitation received only a single response in an open competition and recommends wider solicitation for future ICST research projects. Bringing fresh perspectives and developing new topic experts in other research institutions through future studies would benefit ICST in the long term.

Technical Briefs and Web-Based Training for ICST

Although this topic was not included in the meeting agenda, the committee discusses it in the letter report in view of its importance for the outreach and implementation of the ICST program. The committee was not informed at this meeting how its recommendations on technical briefs and web-based training for ICST made at the first meeting had been addressed. One of those recommendations concerned the costs of producing technical briefs and training material. Another concerned inclusion of local public agencies (such as county representatives) in technical working groups in addition to state DOT, university, and FHWA representatives. The committee also wants more information about technical working groups involved in ICST-related activities, including their specific topics and makeup.

The committee's recommendation on partnering with the National Highway Institute (NHI), AASHTO, and the Transportation Curriculum Coordination Council in preparing future courses is apparently yet to be implemented. FHWA indicated that NHI did not have any training related to intelligent construction. The committee recommends that all FHWA resources, available for training and education development and marketing, including NHI, be exploited in developing technical briefs and webinars, especially if they are used as promotional and educational tools. To avoid overlap between technical briefs and webinars, a strategic approach to information dissemination needs to be taken. Such an approach would include a medium-range plan (for example, for 5 years) and would involve all FHWA offices working on projects in a particular technical area.

Three technical briefs—providing executive summaries on 3D, 4D, and 5D engineering models for construction; automated machine guidance with use of 3D models; and IC—were supplied to the committee before the meeting. A one- or two-page executive brief accompanying the presentation on IC implementation that included a list of technical briefs and webinars produced as well as planned would have been helpful. If possible, such executive briefs on other topics should also be provided to the committee in the future, preferably prior to the meeting. The IC technical brief should have acknowledged the pooled fund study TPF-5(233), mentioned earlier in the IC section of this report. This study is developing a webinar on IC 101 that may be available by the end of this year. As noted earlier, the presentation on FHWA research related to ICST discussed a project titled Addressing Challenges in Intelligent Construction Systems and Technologies, which included developing best practices and case studies (topics that are suitable for technical briefs). However, how this project related to IC implementation activities presented earlier was unclear. A more coordinated approach, especially when conveying information to the committee, would have been helpful.

Concluding Remarks

The ICST program is important. It represents how highways and bridges will be built in the 21st century. The committee feels privileged to be a part of this endeavor. To enhance its participation and be more effective in its advisory role, the committee believes that it needs to improve its interaction with FHWA. It believes that the following suggestions would be mutually beneficial:

1. *Focus on strategic issues:* The committee and the FHWA ICST group need to focus on strategic issues that will benefit the ICST effort. For example, there is an urgent need to focus on the development and upkeep of the strategic roadmap. This document should provide a clear presentation of projects that are under way or planned. Each project should be described in a consistent manner, and its ICST priority should be clearly stated. The committee believes that such an effort would help in identifying opportunities with the potential to achieve significant results and would allow the committee members to make a greater contribution to FHWA's efforts.

2. *Internal review:* It would be helpful for the FHWA ICST group to work with a strategic planning facilitator (if such a resource is available at FHWA) to fine-tune important documents, such as the ICST strategic roadmap, before their presentation to the committee. This would result in the committee reviewing documents that have been more

stringently vetted internally. The committee had the sense that some of the planning documents were being presented as a first round of review.

3. *Written response to committee's letter report:* The lack of a written response to the first letter report significantly hindered the committee's ability to determine whether its stated concerns were addressed. Some concerns were clearly touched on during the meeting, and some were not. A timely written response that comprehensively addresses all comments and questions would be beneficial.

4. *Meeting agenda:* The committee needs to be involved in developing the meeting agenda and should be able to suggest and discuss any topics it considers necessary.

5. *Meeting material:* The material provided to the committee about 2 weeks before the meeting was helpful. This practice should be continued. Copies of presentations should also be provided before or at the meeting. The committee received copies of some, but not all, presentations before or at the meeting.

6. *Meeting presentations:* The presentations should be limited to a few that are necessary, and those that are given need to be consistent in nature, to indicate clearly which issues raised by the committee they address, and to be reviewed and vetted by the FHWA ICST group in-house before they are presented to the committee.

In conclusion, the meeting was productive and useful. The program is making progress on several fronts. The committee now has a better understanding of the program and a better sense of how it can help FHWA through its advisory role. Mr. Cawley, Mr. Nieves, and their group at FHWA must be commended for their dedicated hard work. The committee recognizes the difficulty of bringing together so many diverse activities from several initiatives under one program and moving forward in a coordinated manner. The committee appreciates their sustained efforts in managing this complex task and looks forward to its next meeting, which is scheduled for early spring next year.

Sincerely,

Mary Lou Ralls

Mary Lou Ralls, P.E.
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