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Accelerated Highway Construction

Workshop Series Summary

Washington, D.C., November 16–17, 2000
Indianapolis, Indiana, March 18–19, 2002
Pittsburgh, Pennsylvania, April 10–12, 2002

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Sponsored by

TASK FORCE ON ACCELERATING INNOVATION IN THE HIGHWAY INDUSTRY (A5T60)

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Preface

This report, prepared under the sponsorship of the Transportation Research Board (TRB) Task Force on Accelerating Innovation in the Highway Industry (A5T60), summarizes three workshops held in Washington, D.C., Indianapolis, Indiana, and Pittsburgh, Pennsylvania, in 2000–2002. The objective of this workshop series was to provide a forum for the exchange of new ideas and developments in the field of accelerated construction. All three workshops were sponsored by the TRB Task Force A5T60. The workshops in Indianapolis and Pittsburgh were presented in cooperation with FHWA and AASHTO.

TRB *Special Report 249: Building Momentum for Change: Creating a Strategic Forum for Innovation in Highway Infrastructure,* published in 1996, recommended conducting strategic forums for emerging innovation in highway infrastructure (*1*). The TRB Task Force A5T60—working with AASHTO, FHWA, and industry—elected to conduct these accelerated construction workshops because of the emerging importance of accelerated construction to both the departments of transportation and the traveling public.

The author of this report is Ted Ferragut, TDC Partners, Ltd. The views expressed in the papers contained in this publication are those of the author and do not necessarily reflect the views of TRB and the other sponsors of the workshop series. Each organization will use the information included and the experience gained as a continuum in its efforts to prepare research, policy, and training in this area. This report has not been subjected to the formal TRB peer review process.

Contents

Executive Summary 1

Washington, D.C., Workshop 3

ACTT—Accelerated Construction Technology Team Pilot Workshop Concept and Strategy 19

Indiana Department of Transportation ACTT Workshop 21

Pennsylvania Department of Transportation ACTT Workshop 38

Summary of Workshop Output and Closure 54

References 59

APPENDIXES

A. List of Participants 60
B. Guidelines on Organizing and Managing an Accelerated Construction Technology Team Workshop 66
C. Flowchart on ACTT Critical Elements 70
D. Acronyms and Abbreviations 71

Executive Summary

On November 16–17, 2000, the Transportation Research Board's (TRB) Task Force on Accelerating Innovation in the Highway Industry (A5T60) conducted a workshop in Washington, D.C., to explore the issues associated with accelerating construction. Fifty executives and engineers from around the country shared comments and thoughts on the subject. Various statistics show that accelerated construction needs will grow considerably over the next decade, especially considering traffic growth of 50% to 60% with little to no capacity increases.

Presentations and discussion took place on the following subjects:

- Corridor analysis approaches,
- Prefabrication and modular technology,
- Utility and railroad agreements,
- Accelerated construction quality control (QC),
- Worker health and safety issues,
- Public safety through work zones,
- Executive information,
- Intelligent transportation for construction,
- Innovative financing,
- Alternative contracting strategies,
- Mobility measures,
- Incentive programs,
- Right-of-way (ROW) strategies,
- Training and education,
- National management council, and
- Technology transfer.

Within each category, the attendees discussed many subinitiatives that need to be addressed, including research, implementation, experimentation, and deployment, for the country to properly advance accelerated construction. Many participants were particularly concerned that many of the solutions require a multidisciplinary, multitiered systems approach that in turn requires strong leadership.

The second workshop, cosponsored by Task Force A5T60, AASHTO, and FHWA, was held in Indianapolis, Indiana, on March 18–19, 2002. The Indiana Department of Transportation (INDOT) was planning major rehabilitation and expansion of the 13-mi west leg of the Interstate-465 (I-465) corridor around Indianapolis. The project was relatively complicated in that it included airport expansion and connection, along with major interchange construction. INDOT normally would commit to three to four design contracts and four to five construction contracts, allotting 5 to 6 years for construction. However, INDOT wanted to determine whether the corridor construction could be accelerated to minimize inconvenience to the public—reducing the "orange barrel syndrome." INDOT wanted to explore using the multidisciplinary approach discussed at the first workshop.

The third workshop, also cosponsored by TRB Task Force A5T60, AASHTO, and FHWA, was held in Pittsburgh, Pennsylvania, on April 10–12, 2002. The Pennsylvania

Department of Transportation (PENNDOT) was planning major rehabilitation of existing PA-28 as a limited access facility for its entire length except for the project area, which is a 2-mi-long section of four-lane, undivided, free-access highway with at-grade intersections and driveway accesses. PENNDOT proposed improvements included elevating and bifurcating PA-28 to accommodate widening to four 12-ft lanes with shoulders and median barrier, including several grade-separated interchanges and arterial realignments. The roadway is supported by a retaining wall adjacent to active railroad tracks along the northbound lanes and development including numerous historic resources, residences, and businesses and a church adjacent to the southbound lanes. A conventional approach might take two to three construction projects over a 3- to 4-year period. PENNDOT also wanted to explore the use of a multidisciplinary approach.

The multidisciplinary approach called for a national team of experts in key technical skill areas to work with the department of transportation (DOT) officials to determine whether there were creative ways to accelerate the corridor work. The process was extremely successful. In all, more than 50 ideas were brought to the attention of each DOT.

The principal idea presented to INDOT for the I-465 project was that with nontraditional financing and alternative contracting strategies, the project could be completed with one construction contract in 3 years, which would eliminate 4 years from the conventional approach. In Pennsylvania, the principal idea presented was that the project could be built in 2 years with only 1 year of construction actually affecting traffic. The accelerated construction requires being creative and aggressive on the uphill wall construction and applying some advanced geotechnical strategies.

According to both DOTs, the process clearly showed the benefits of the multidisciplinary approaches. The process also showed the interdependent nature of many of the skills.

Representatives from AASHTO and FHWA expressed interest in continuing the workshop series around the country for other states willing to participate. The process eventually could evolve into a technique that the DOTs could apply at the early planning and design phase of a corridor project.

CHAPTER 1

Washington, D.C., Workshop

OBJECTIVES

The objectives of the workshop were as follows:

- Collect information concerning the current state of accelerated construction,
- Identify emerging issues, and
- Identify innovative strategies that may accelerate the adoption of new ideas.

PLENARY SESSION

The workshop was held at TRB in November 2000. More than 50 national experts shared experiences and offered suggestions as to how the innovation process might be expedited to address the concept of accelerated construction.

Opening Remarks

In his opening remarks, Donald Lucas, former Chief Engineer of INDOT, stated that the results of this workshop must focus on customers and their expectations. He defined customers as both the traveling public and the businesses that depend on the facility for the movement of goods and services and for access to and from the highway. He presented a series of open-ended questions relevant to accelerated construction:

- Are certain innovations more critical to the accelerated construction requirements of the future?
- Could time-based construction incentives inadvertently compromise safety considerations? Are workers safe from fatigue-related and accident-related injuries or death? How safe are the customers using the facility during construction?
- Could time-based construction incentives inadvertently compromise QC and inspection functions? Do time-based incentives overwhelm the few quality-based incentives currently used by DOTs? Will this affect the ability to "stay out"?
- Do we have the proper procurement tools in place to create both equity and innovation between the DOT and the construction industry? Are performance specifications, best-value contracting, design–build (DB) contracting, and other techniques the way of the future in accelerated project environments?
- Can we differentiate customer mobility demands between free-flowing urban freeways, rural two-lane highways, and mall intersections? Or is "open" the operable word? What are "customer expectations"?
- How are DOTs identifying, structuring, and sharing best practices, research findings, and technology advancements? How are DOTs and the construction industry preparing for a greater volume of accelerated construction efforts in the future? Are we

preparing the workforce? Do we have the skills identified?

Mr. Lucas also reported on the recently completed National Quality Initiative (NQI) Survey (*2*), which clearly shows an emerging issue with construction and mobility demands. Although statistics showed an increased level of satisfaction with the highway members of the public use most often (from 40% to 65% from 1995 to 2000), they also showed an increased trend in dissatisfaction (from 17% to 24% from 1995 to 2000). The survey shows that the combination of congestion increase plus delays associated with construction and maintenance projects are seen as combined negatives.

The survey also showed some significant dissatisfaction with work zone issues:

- Construction signage (21%),
- Safety features (25%),
- Detour signs and directions (26%),
- Speed of road repair (56%),
- Traffic congestion (57%), and
- Time delays (62%).

Mr. Lucas noted that dissatisfaction numbers of this magnitude would normally close private-sector companies. Mr. Lucas also pointed out that from 1980 to 1999, the United States experienced a 76% increase in vehicle miles traveled, whereas lane miles only increased by 1% (*3*). The lane mileage figures more than likely will not increase dramatically because the survey also showed that the public generally is not amenable to tax increases or the addition of roads in their neighborhoods to provide this additional capacity. Congestion indices currently show that extremely or severely congested roadway mileage more than doubled from 1982 to 1997. Uncongested mileage on the system shrunk by nearly 50%.

Mr. Lucas also remarked that the 160,000 mi of the National Highway System (NHS) and the 300,000 mi of the arterials are moving toward middle age. Although national funding under

FIGURE 1 View of congestion.

the Transportation Equity Act for the 21st Century (TEA-21) increased by nearly 40% to address these issues, this has led to many more work zones throughout the country. FHWA estimates that on the NHS alone, during the peak summer roadwork season, nearly 13% of the system is under construction, leading to approximately 3,000 work zones at any one time.

Work zone fatalities, unfortunately, are also on the increase—to more than 1,000 fatalities in 2000, on the basis of statistics gathered by the National Highway Traffic Safety Administration's Fatality Analysis Reporting System. This is approximately a 20% increase over the last 6 years. Approximately 42,000 people are injured annually as a result of motor vehicle crashes in work zones.

He pointed out that the public appears to support short-duration, high-intensity shutdowns of projects to conduct long-lasting repairs. Nearly 67% of the public supports a 1-week closure of a facility if the work is done in accordance with the promise to stay out. This may offer an important window of opportunity into the future.

These statistics all look backward, Mr. Lucas noted. "What is not known is how construction acceleration may have affected these numbers. Did acceleration reduce the overall exposure rates? What impact did the movement of work to nighttime do to these rates? Or to weekend work? And to the future—how do these trends translate to future program decision making?"

Corridor Approach

During this session, speakers addressed the question of assembling work into discreet packages by analyzing corridors and incorporating innovative project assembly to both minimize overall construction impacts and to accelerate work completion. Increasingly, DOTs are considering a corridor approach to work. This session focused on how corridor needs can be addressed in such a way as to minimize the number of construction sites and the amount of construction time required.

Mr. Pete Rahn, Secretary of Transportation for the New Mexico State Highway and Transportation Department (NMSH&TD), presented his department's policy for addressing major corridor improvements, which deviates from its traditional technique of improving 5-mi sections of roadway. NMSH&TD's corridor improvement technique has four key components:

- Obtain adequate and creative funding,
- Develop innovative contractual documents,
- Involve the public fully and completely throughout the process, and
- Organize and stage the work so that there is a pronounced reduction in "orange barrels" during construction and into the future.

Secretary Rahn was particularly concerned that the highway budget was filled with projects—the concept that "everybody got something" minimizes the NMSH&TD's ability to produce measurable results. "Nothing ever appeared to be accomplished," Mr. Rahn stated. He believes that if planned and executed properly, corridor management can better address a more complete restoration strategy and can reduce the overall number of work zones that may be required to complete the activities. The corridor approach has upgraded 1,300 mi of deficient highway in the New Mexico system. During corridor construction, accidents have dropped 12%. Secretary Rahn noted that one critical point in corridor analysis was goal setting. "You are half

way there by simply stating what the goal is," Rahn said, "Leave the creativity to the engineers and contractors to do the rest." In setting longer project limits with higher dollar volumes and shorter construction schedules, he believes that many projects were successfully accelerated.

John Bourne, I-15 Reconstruction Project Director, Utah Department of Transportation (UDOT), discussed the I-15 corridor project. This 17-mi, $1.6 billion, 4½-year corridor project, with 144 bridges replacements, 3.4 million yd^2 of pavements, and major interchange construction was completed on time and basically in accordance with the budget. Although UDOT used innovative design–build (DB) contracting, warranties, time incentives, and other mechanisms, Bourne supported Rahn's statement that goal setting and focus is extremely important. "This corridor project was also driven by a goal—complete the work in time for the 2002 Winter Olympics. Projects of this magnitude must have a 'hook' or there is little incentive," stated Bourne.

Overall, the UDOT's goals to reduce time, maintain quality, and control costs were all met. What lessons were learned? Bourne believes in

- Selecting the best value, not the lowest costs;
- Clearly defining the challenges; and
- Accepting new roles and responsibilities, reallocating risk, and improving partnering.

As a contracting mechanism, the DB concept breaks from tradition and has been successful. A lesson that must be emphasized, however, is that over time, the constant pressure wears on individuals and on the team, destabilizing the effort through lower morale and more difficult decision making. Future projects must address the human factor for both the DOT and the contractor.

Gary Taylor, Chief Engineer, Michigan Department of Transportation (MDOT), discussed a relatively new concept for corridor management called "mix of fixes." This concept determines the time pavement sections are due for (*a*) capital preventive maintenance, (*b*) rehabilitation, and (*c*) reconstruction. Mix of fixes includes a road quality and forecasting system integrated with a pavement management system (PMS). Strategies for the system are based on the PMS as well as a road quality forecasting system. "By integrating these concepts," Mr. Taylor noted, "the DOT hopes to reduce the number of miles that will need reconstruction and hence reduce the number of critical long-term lane closures." Mix of fixes is a way to smooth the distribution of dollars required for construction while at the same time reducing the number of work zone closures required in a corridor or in a district.

Capital preventative maintenance must be used on roads with a remaining service life minimum of 5 to 7 years. Chip seals, diamond grinding, and crack sealing are examples of pavement preservation strategy with varying lives to meet a set of condition goals. These techniques limit disruption to traffic. Rehabilitation strategies target 10 to 20 years and include overlays, patching, rubblization, and overlays. Reconstruction aims for a design life of 20 years or more.

The PMS uses remaining service life categories—I to VI—as a function of the number of years of remaining life. "Our objective is to constantly try to move pavements 'up' in the scale," noted Mr. Taylor. Pavement strategy analysis uses annual budget and mix of fixes to predict what the network condition will be in the future. For example, if all resources are spent on any one of the three areas, the system does not fare well. The resources must be distributed among the three. If a mix of the three is used, the same investment improves the overall network—

reducing the number of poor pavements. The tool allows for "what if" games to determine the effect of different funding levels, maintenance and rehabilitation strategies, and so forth

Although a mix of fixes is used to reduce poor pavements, to increase good pavements, and to manage fair pavements, it also may have huge potential to minimize construction delays and to provide a consistent level of work. The process has worked in Michigan—the poor pavements are being reduced, although the excellent pavements have not increased significantly. MDOT will improve the modeling in the future to account for the effect on work zone reduction.

Reducing Years of Major "Megaprojects"

Many highway projects in the planning stages are very complex and expensive and dramatically affect the public. INDOT, for example, reports it currently has six extremely large projects that will require large capital and tremendous creativity. Sometimes called megaprojects, these projects take years to plan, address many options, and require the most experienced personnel. From an initial timeline that may show 6 to 8 years to build a project, many DOTs are attempting to identify creative ways to accelerate the construction and to minimize the effect on the public. Although projects sometimes linger 10 to 14 years in project development, once the plans and finances are ready, the pressure to "accelerate and deliver the project" becomes nearly overwhelming. This session focused on high-visibility projects that were successfully completed ahead of schedule and that received high marks from the public. The DOTs also used many creative "stay out" techniques by improving quality elements of the design and construction.

Jim Slifer, Highway Director, Illinois Department of Transportation (IDOT), discussed IDOT's accelerated construction program that began more than 20 years ago with the Eden Expressway in Chicago. This 14-mi-long reconstruction was completed in just 2 years. IDOT elected to build a "slow" pavement with a high service life. The high-service, continuously reinforced concrete pavement is still performing excellently after 20 years of extremely high truck traffic. IDOT has completed the Eisenhower Expressway and the Dan Ryan Expressway as well. The Kennedy Expressway was completed in 3 years (1992–1994) while accommodating 250,000 vehicles per day (vpd). INDOT also recently completed the Stevenson Expressway. "Our next challenge," stated Mr. Slifer, "is to do two 'megaprojects' at the same time. These will include another portion of the Dan Ryan Expressway as well as the I-80, I-90, and I-94 merge near the Indiana border. Both will be done in a 2-year window." The IDOT position is that the public will no longer tolerate 5-year construction zones. The trend for accelerated construction is even reaching southern Illinois with the reconstruction of I-74.

To what did Mr. Slifer attribute IDOT's success on these projects? "Without a doubt, it's planning and communication. Planning is more than just the details of the project. It is working with the public, both those impacted by the construction and those using the facility." IDOT has used focus groups and user surveys extensively, public relations firms, mascots, and catch phrases such as "Jack Hammer" and "Mission Impossible." By providing the public with information, IDOT and the press became allies. IDOT also is looking to intelligent transportation system (ITS) solutions to keep the public informed during construction.

During construction, the key to success is a solid relationship between the contractor and IDOT. Very little good will happen without communication and partnering. IDOT uses cost + time (A + B) and lane rental extensively and rates these tools as very successful. In addition, IDOT requires the contractor to do most of the QC on the project.

Technically, IDOT likes to build structural shoulders on the Interstate as temporary riding

surfaces during reconstruction. This requires the shoulder to be raised during resurfacing operations as well. High early strength concrete patches and prefabricated structural steel have all played key roles in accelerated construction. IDOT is exploring alternative designs for pavement selection. However, utility companies and utility relocation are still very difficult to deal with on many projects. IDOT is also beginning to look at corridor improvements to dispel the "always out there" perception.

Dale Swanburg, Vice President, Walsh Construction, discussed his firm's experiences on the Chicago projects. He listed important details that other DOTs should consider when looking to accelerated construction improvements:

- Review and check plans and estimates thoroughly;
- Conduct informative and detailed preconstruction conferences;
- Untangle utility agreements and clearly define the roles and responsibilities among the DOT, the contractor, and the utility owners;
- Prepurchase long-lead-time items such as structural steel and sign trusses;
- Address subcontractor limitations—the more in-house effort there is, the fewer coordination problems will occur;
- Allow for alternative material selection, especially for temporary construction;
- Improve value engineering by
  - Increasing the percentages allowed remaining with the contractor, and
  - Allowing submissions that account for time-savings as well as money savings;
- Partner with the decision-making authority; and
- Not only sustain and improve incentives for time but also create a better approach toward quality incentives.

Mr. Swanburg identified some significant downsides to accelerated construction. Contractors will generally only maintain two work shifts at 12-h each to run a 24-h-a-day, 7-day-a-week construction operation. These accelerated projects require the best staff available; when all highway projects are defined as accelerated, they are very difficult to staff. Even a skilled workforce is tested to the limits. Accelerated construction projects without skilled labor can be deadly. The longer the project is, the more the system is tested by strained relationships and tension between people and organizations. Safety must be watched; toward the end of the season, the effort begins to take its toll. Many key personnel simply wear out and need forced vacation time. Unfortunately, company personnel have suffered from an increase in strained personal relationships, broken marriages, and so forth. His company is considering requiring his employees to take "forced" vacations and time off.

"I know the trend is for more acceleration, but we have to choose our projects realistically. It will do us no good to meet every project goal and incentive and to lose quality people in the process. I am not sure what the future will require, but innovative solutions to the people issues are as important as any the steering committee will identify."

Mike Seigfried, Chief of Construction, New Jersey Department of Transportation (NJDOT), discussed the NJ-4 and NJ-17 Interchange in Bergen County. The original interchange was built in 1932; it is the crossroad for the entire region. Reconstruction called for an additional interchange, two three-level flyover ramps, and a service road. The reconstruction needed to account for entry and exit to a major shopping mall. Although there were many human obstacles, especially the effects of long workdays for long periods of time, a subtle challenge for NJDOT

was to change the way it approved contractor submissions such as shop drawings and materials. Overall, the project was completed ahead of time with nearly $7 million in bonuses added to $53 million of work effort.

John Deatrick, City of Cincinnati Transportation and Engineering Department, discussed Cincinnati's Fort Washington Way project. This urban project also demanded considerable preconstruction public involvement. Nearly 200 public hearings and meetings were conducted. Even though the project was well planned, many of the "smart" ideas surfaced after construction started. "The key to our success," stated Mr. Deatrick "was having a very open communication system and a quick decision-making mechanism. I cannot minimize its importance."

Reducing Project Hours—One by One

The purpose of the following discussion was to share experiences on how very high-intensity, short-duration projects can be managed.

Randy Ashmore, Ashmore Brothers, discussed a world-class reconstruction of Runway 9R-27L at Hartsfield Atlanta International Airport. The 2-mi runway removal and replacement project was completed in 33½ days with more than 1,000 workers typically on site. This project had a $175,000-per-day disincentive but no incentive. Mr. Ashmore pointed out the critical importance for expedited decision making with contracting authorities. A quick contractor decision-making system can be minimized if the authorities do not have a similar system. Although one of the most critical decisions was to save the original base (done through a value-engineering proposal), much of the project related to human factors: obtaining skilled workers, being safe, feeding the workers, and cooperating with others continuously and positively. The work was conventional—it just took so much more of everything—from saws to trucks to worker lunches.

Neil Hawks, TRB Special Programs Division Director, reported on the results of a "Get In–Get Out–Stay Out" workshop in California in 1998. The focus of the workshop was on the rehabilitation of I-710 between the Port of Long Beach and Los Angeles, which passes through nine municipalities. Teams of 12 members each attacked the problem; each team had equal skill sets. The participants were instructed to develop a solution that would meet the long service life goal identified by the workshop steering committee. Two of the teams were charged with producing asphalt solutions; the other two teams were charged with concrete solutions. The creativity and energy in the groups were exceptional; many solutions were extremely creative. There was some similarity in the techniques. All of the teams used ITS technologies and public information campaigns. All of the teams used recycling techniques. The workshop effectively pointed out the legitimate alternatives possible to build long-term pavements under accelerated construction conditions. None of the pavement solutions was improbable or fanciful. The mix of expertise on each team proved to be very synergistic. The teams also applied underused technologies such as unbonded concrete overlays and stone matrix asphalt as base course. The teams recommended the following follow-up activities:

- Hold more workshops around the country addressing real projects;
- Use a cooperative, multidisciplinary approach to project design, including nongovernmental interests; and
- Undertake focused national research.

The Safety Issue—Improving Our Record

During this session, three DOT safety specialists discussed emerging concepts in handling work zone traffic from both flow-through and worker and public protection perspectives. They discussed the trade-offs and what might be expected in the future for work zone management and safety.

Tom Hicks, Traffic and Safety Engineer, Maryland DOT, discussed Maryland's future, which is basically striving for balance. Public and worker safety issues both need to be considered. The *Manual on Uniform Traffic Control Devices*, Part 6, suggests that traffic flow be as uninhibited as possible with safe roadsides (*4*). Before roadways or lanes are closed, the Maryland DOT undertakes traffic demand and lane closure queuing analyses. During construction, traffic flow is monitored. The Maryland DOT also requires backup plans for incidents or unusual flow.

Mr. Hicks suggested that future project planning will undergo extensive analysis of stage construction examining traffic flow. For example, a typical project safety plan will include material delivery and movement into and onto the project site. The safety plan will be coordinated with enforcement personnel to ensure that no organizational conflicts exist. Techniques such as telecommuting, ride sharing, bus service, van pool, and 4-day workweeks will be promoted. Operational techniques, such as reversible lanes, shoulders, and speed controls at merges, will be considered. Maryland DOT is looking to ITS technologies for construction control as well. The University of Maryland is developing guidelines to improve traffic operations in work zones, especially to determine the economic balance between construction cost and delay costs, with some advanced and innovative software.

FIGURE 2 Work zone slowdown sign.

Phil Ditzler, Work Zone Safety Team Leader, FHWA, discussed the growing number of states using queue length policies, ramp closures, weekend closures, and otherwise intense techniques to move traffic during construction. Individual policies vary, but most show the trend toward more aggressive control of both construction windows and traffic flow. States also are beginning to use public information campaigns to announce very critical, short-duration shutdowns. Mr. Ditzler again noted that although traffic is increasing, capacity is not. Work zone fatalities are increasing, as are accidents. It is clear that many more states will need to address these techniques.

Dave McKee, Director of Technical Assistance, American Traffic Safety Services Association, presented the industry's response to FHWA's vision of no delays or accidents in the work zone. To do that, he believes the industry must use more ITS innovation. In an effort to reduce delays and crashes in the work zone, one objective would be to provide road users with "real time" information that allows better decision making by motorists regarding alternate routes they can use to avoid work zones. The traditional ITS components for work zones have been limited to queue detectors, portable changeable message signs (PCMS), and highway advisory radio. However, the integration of these components into a much larger architecture is the future. Having all these components "handshake" with the system will give transportation agencies and motorists more information and better use of the infrastructure. Emerging portable devices that can be used now include traffic management, traveler information, roadway weather conditions, real-time photos, incident detection, highway advisory radio, portable traffic cameras, and PCMSs all working within an established architecture.

Companies are now coming on line with services that provide advanced technology for use in highway construction and maintenance work zones. The new technology is usually combined with current off-the-shelf equipment to provide smart work zones. For example, one company used its computerized highway information processing system to implement a fully automated traffic management system for use during the major reconstruction of US-22 in eastern Pennsylvania. During the preliminary design stage, the need to divert some of the traffic from the work zone was identified; this eventually led to the installation of a real-time traffic control and incident management (IM) system as part of the project. This step was considered necessary to provide for the safety of the traveling public and to maintain efficient traffic flow.

These types of services are expected to become more common as the demand for them increases.

Alternative Contracting

Ever since the 1991 European Scan Study of Asphalt Technology, FHWA and the DOTs have experimented with many new contracting options. Although the low-bid process has been the staple for many years, accelerated construction demands require a process that allows for more contractor creativity, considers the transfer of risk from one organization to another, and better compensates a high-performing contractor.

Professor Stuart Anderson, Texas Transportation Institute, discussed the effect new techniques could have on future contract administration. Obviously, time incentives based on A + B and lane rental have had huge impacts. As pointed out in several research and experimental projects (*5*), other techniques may prove to be just as valuable:

- A + B + quality,

- A + B + warranty credit,
- A + B + incentive, disincentive,
- A + B + traffic control bonus,
- A + B + past performance,
- A + B + warranty with performance payments,
- Best-value selection,
- Lump sum bidding,
- Performance incentives,
- Flexible notice to proceed,
- No-excuse bonus,
- Multibid award,
- DB,
- Build–operate–transfer or build–operate–own,
- DB–finance–lease back, and
- Indefinite delivery–indefinite quantity contracting.

Although there is concern within the highway community about different elements of alternative contracting, Professor Anderson suggested that the highway community research nonhighway industries as well. Other industries may prove to have additional new ideas worth exploring, several of which are included in this list.

"As strange as the terms sound today, so was A + B 10 years ago. There is merit in exploring some of these concepts," said Professor Anderson. "The future will demand even more creative and innovative solutions. They may be in some of these concepts."

Ken Leuderalbert, Manager, Quality Initiatives Office, Florida DOT (FDOT), reported on Florida's experience with innovative techniques. They include the conventional A + B and lane rental, along with DB, liquidated savings, bid-averaging methods, and lump sum payments. FDOT's analyses of all these new techniques have shown an average time-savings of nearly 24%, with cost savings of 8.5% as well.

Tanya Mathews, Past Chair Design–Build Institute (DBI), discussed the growth and maturation occurring in DB. DBI recommends a series of "dos" and "don'ts" developed because of this experience. For more information, see www.dbia.org/pubs/pd_intro.pdf. Design for accelerated construction is especially appropriate because the team can integrate constructability into the design process very efficiently.[1]

The attendees then divided into smaller breakout groups to identify more detailed needs to address accelerated construction.

OBSERVATIONS AND IDENTIFICATION OF NEEDS

As a result of the brainstorming workshop, workshop attendees offered the following observations:

No Single Solution

There is no single solution—no "silver bullet"—that will solve the problem. Accelerated construction is a systems issue, which requires many disciplines and technologies.

Importance of Accelerated Construction

Others need to be made aware of the importance of the problems and the possibilities for solutions.

Information, Statistics, and Facts

Good statistics to paint the appropriate picture for the public, legislators, and industry personnel are in short supply.

Congestion and Construction Linkage

Congestion and construction needs should be connected in the minds of both the public and politicians. Congestion will only increase because capacity is relatively stable. Construction and maintenance needs exacerbate the issue. Many large metropolitan areas are approaching a system failure; there may be severe damage if we do not start accelerating the issue and the solutions.

DOT System Approach

All sectors and departments within a DOT overlap and have responsibilities in accelerated construction; this must be emphasized. A full system approach is the only way to advance future efforts.

Responsibilities

If the DOT engineers and the construction industry do not address accelerated construction, politicians eventually will. Through solid public relations, the highway community needs to tell politicians about the problem and to describe the possible solutions.

Labor and Experience Issues

Both the contractors and the DOTs will experience labor shortages and the imminent retirements of experienced, critical personnel. Many DOTs are currently working at an "overload" pace. There is no easy solution, but the subject must be discussed and studied.

Legislation

The next highway bill should provide some focus to accelerated construction, possibly through a major research initiative.

Technology Transfer and Sharing

Although many ideas have been generated, in practice, no ways exist to share the information effectively. States need to improve the technology-sharing aspect of accelerated construction.

National Focus

A national coordinating effort on accelerated construction is needed. Serious consideration should be given to forming an accelerated construction management council or a similar type of structure. It should be multidisciplinary and should link all appropriate public and private-sector interests. Many of the recommended programmatic elements may happen in due course. However, as noted throughout the workshop, no singular element is strong enough to solve the problem alone. Many techniques must be used collectively. An overall strategic approach with management council guidance would be very effective.

Setting Goals

For the innovative ideas to bear fruit, agencies should consider setting maintenance of traffic policy goals that would guide the overall construction program for the future. Whether it is a fixed number of lanes during peak hour or a fixed level of service, such public and targeted goals would help the construction community package innovations to meet these goals.

Project Limits and Larger Contracts

Many future projects will challenge the traditional size and value of today's construction contracts. Project limits will be as much set by traffic controls and public expectations as by the ability of the small- to medium-sized construction firm to provide the services. In the future, project-defining terms such as "5 mi and $50 million" will be inputs and not necessarily controlling factors.

Lane Closure Policies

A survey of all states should be conducted to collect information on the current policy concerning construction restrictions as they relate to lane closures, maintenance operations, and so forth. It would be most effective if the information referenced 10 years ago, today, and projections for the future.

Work Zone Safety Data

The industry does not have high-quality work zone safety information. Better work zone safety accident records should be collected.

Congestion and Traffic Increases

The industry needs to better inform the public and politicians on the relationships among total traffic volume, truck traffic volume, and the need for lane closures during construction. Data that

appear in the recently completed NQI survey foreshadow serious problems ahead. It is clear that by increasing the number and severity of construction work zones, motorists' current dissatisfaction with congestion will be fueled even further. The ability to maintain or fix the system will continue to meet serious challenges. A better array of statistics and a better delivery of this information to the public and politicians can begin to condition attitudes about these future consequences.

ITS: Technology and Innovation Flow-Through Safety

Portable, affordable, and integrated ITSs that specifically address construction management are now coming on line. An integrated construction–ITS task force could identify the current state of the art, identify the gaps in the technology, develop national experimental and demonstration projects, develop construction specifications and pricing structures, and organize workshops and other technology transfer programs. This effort may be worthy of a separate, targeted structure within the ITS program. At a minimum, the ITS industry should provide more instructional information on how to use advanced traffic information systems to communicate construction information to motorists—by radio, Internet, wireless—along with IM systems and services.

Education

There is a significant gap in translating work zone safety and work zone flow through to the construction workforce. Safety specialists may be able to better translate this information to the construction personnel. Additionally, driver education about work zones as they increase in numbers and severity must be improved. This should start with driver education at the earliest ages.

Corridor Improvements

The mix-of-fixes and corridor management approaches take a more systematic approach to construction management. The mix-of-fixes approach suggests that a more structured selection of construction and pavement restoration strategies can help smooth both budget and traffic delays. Corridor management approaches to both reconstruction and maintenance may be able to assess traffic impacts better than the conventional project-by-project approach. Mix-of-fixes and corridor management need to be explored as both budget and traffic management tools. Corridor management projects under way by NMSH&TD, Virginia DOT, and the Washington, D.C., District Transportation Department should be tracked closely to determine their effectiveness in managing traffic. Both techniques may be invaluable in reducing the number of work zones required in the future and may be excellent points to communicate to the public and to politicians.

Contracting and Procurement Advancements

New, improved innovative contracting techniques need to be explored; better knowledge of how the current mechanisms are working should be organized and assembled. DB, warranties, A + B, and lane rental have gained credibility but will need to be further refined and improved. A more comprehensive approach to selecting and matching innovative contracting techniques to specific

situations is needed. The approach would consider DB, draw–build, bid–build, operate, maintain, finance, warrant, and others and would suggest the best way these might be packaged for specific projects or corridors. Draw–build and DB are key elements for accelerated construction in the future. The current $50 million threshold may need to be lowered.

Performance-Related Specifications

There needs to be a stronger focus on performance-related specifications (PRS). Method specifications were never developed with accelerated construction in mind; in fact, they may actually hinder innovation and speed of construction. There currently is a movement to organize a national PRS technical working group; this should be done with a focus on its applicability to accelerated construction needs.

Value Engineering

Several agencies have used value-engineering techniques to address accelerated construction methodologies. Consideration should be given to educating the DOTs and contractors on how this tool can be better used in accelerated construction environments by reducing time or improving quality without increasing time.

Quality Incentives

There is a subtle (some would say loud) message that accelerated construction is more important than high quality. If there is a head to head on this issue, time appears to win over quality. With this in mind, incentive-based quality measures need to be developed that can "compete" with the time incentives already in place. A $25,000-per-day time incentive can dwarf a $2,500 per day incentive for a mile of smooth pavement. In addition, ways should be found to "carry over" credit to contractors who have done high-quality work on previous low-bid projects. This concept needs to be explored more aggressively.

Corridor Contracts

Corridor contracts that combine construction and maintenance operations may lead to better traffic management. Contract models need to be developed and evaluated. Inherent in these models would be that contractors would receive incentives for keeping overall traffic impacts below certain threshold limits. Contractors also would receive quality incentives.

Stay Out Concepts: More Robust Designs

Accelerated, high-visibility projects should be reconstructed using more robust designs than those used for normal construction. Higher-order (and higher initial cost) designs that extend service life are probably better investments when examined from life-cycle and user-cost perspectives. In addition, if more construction time is required to build the higher-order designs, it can be justified with the "staying out" message. The public may very well support this concept. The premise needs to be addressed more analytically. However, more focused research on

accelerated long-term pavement performance and specialized testing to identify potential durability problems are needed.

Prefabrication and Modular Technology Advancements

Prefabrication and modular lift-in construction needs to be better understood and evaluated. Pockets of experience exist, but information has not been coordinated. This concept will grow with better exposure and focus. Tools that predict performance with some assurance are needed. High-visibility work generally requires the owner or contractor to make predictions as to performance. The tools are coming on line but will require understanding and training.

Accelerated Construction QC

There is a pressing need for better inspection and QC tools and procedures for accelerated, short-duration projects. The ability to prevent, detect, and immediately fix quality problems without affecting time requirements is critical. Research is urgently needed for nondestructive, lightweight testing tools in all material control areas. Finally, more tools that can predict and correct potential durability problems need to be developed. The need to predict performance (or distress) is inherent to risk analysis for warranties, PRS, and operating expense determinations. Long-range items, such as structural steel or sign structures, could be procured in advance for accelerated construction projects. Additionally, better tools are needed to inspect below pavements before construction.

Utilities

Utility delays significantly affect accelerated construction operations. More innovative solutions are required for both short- and long-term time-sensitive construction projects. A strategic national study was suggested to investigate the following:

- Utility industry responsiveness (or lack thereof),
- Incentive-based utility agreements,
- Corridor approaches to utility agreements,
- Means for highway owners and their contractors to perform utility work, and
- Nondestructive tools to help locate and pinpoint utilities.

Of all of the suggestions, the most intriguing was the possibility of using incentive- or disincentive-based contracting techniques, including lane rental, in utility agreements.

Worker Health and Safety

The safety and welfare of the workforce is important. Barriers should be required to protect the workers. These barriers need to be part of the construction equation. Workers and managers are under significant stress in these high-visibility, accelerated projects. The longer the project takes, the more the initial enthusiasm wanes and the more disagreements become common. All this is

FIGURE 3 Nondestructive QC testing.

despite the fact that DOTs and contractors tend to put their best people on these projects. Most use only two work shifts although these projects may run 24 h a day and 7 days a week. Stress is not limited to just the contractor or DOT workforces—it also affects a worker's family relations. This experience should be studied further with possible remedies identified and communicated to the broader community.

Technology Transfer

A very aggressive program needs to be developed that collects and disseminates the many creative accelerated construction techniques currently used by DOTs and contractors. The new program should include formal outreach through workshops, newsletters, and websites. This recommendation reiterates the fact that no singular innovation will solve the accelerated construction problem. There were several specific suggestions that FHWA dedicate one resource center directly for all national accelerated construction issues.

Training and Education

One critical need is workforce education that can address all of these issues. It is important that any education program focus on a multidisciplinary approach that includes DOTs, contractors, consultants, and the labor force. It should be approached nationally, should be industrywide, and should have broad participation. Although it is common to say that designers need to have a better understanding of construction, this becomes very apparent in accelerated construction. In addition, more consideration should be given to finding ways to integrate constructability reviews into the design phase without compromising a contractor's abilities to bid on projects.

ENDNOTE

1. Since the workshop, the FHWA has published a final rule in the December 10, 2002, *Federal Register* to implement regulations for DB contracting as mandated by Section 1307(c) of TEA-21. The regulation allows, but does not require, the use of DB contracting procedures. The final rule was effective on January 9, 2003.

CHAPTER 2

ACTT—Accelerated Construction Technology Team Pilot Workshop Concept and Strategy

Two pilot workshops were conducted subsequently not only to address the comments included in the previous chapter but also to focus on specific projects or corridors DOTs are considering for actual construction.

KEY BARRIER

The task force recognized there are many reasons why innovative strategies take an exceptionally long time to implement. In the case of accelerated construction, although the movement highlights certain innovative strategies and technologies, it requires strong leadership and organizational momentum.

> *Innovation that requires a multidisciplinary, multitiered systems approach will not be accelerated unless one of the organizations affected assumes a strong leadership role that is fully recognized and endorsed by the other organizations affected.*

PURPOSE

The purpose of the pilot workshops was to identify corridors in the preproject development phase that could benefit from a multidisciplinary review of potential acceleration strategies. The two pilot workshops were established to bring together a national team of recognized experts in various technical skill areas (coined the ACTT—Accelerated Construction Technology Team) to meet with the skill areas counterparts in the host DOTs. Over the course of several days, the ACTT and the host DOTs would share experiences and discuss innovative ways to accelerate the construction within the corridor.

The workshops, as envisioned, would incorporate aspects of a constructability review that would be performed before the establishment of project limits and at approximately the same time environmental assessments (EAs) were under way. The ACTT workshops would include plenary sessions, breakout sessions, skill set interaction, closing remarks, and follow-up action plans.

SPONSORSHIP

FHWA and the AASHTO Technology Implementation Group (AASHTO–TIG) both agreed to work with the task force in the two pilot workshops.

SKILL SETS

The three organizations identified the general skill areas that might need to be included in a specific workshop:

- Innovative financing,
- Innovative contracting,
- Work zone traffic management,
- Mobility,
- Utility management,
- Corridor improvements,
- Prefabricated and modular construction,
- Long-life pavements,
- Geotechnology,
- Maintenance,
- ROW,
- Accelerated construction QC,
- Construction ITSs,
- Training and education,
- Constructability expertise,
- Communications and outreach,
- Worker health and safety, and
- Long-life bridges.

This list helped to identify the potential skill sets that might be required in any corridor study.

INDOT hosted the first workshop on March 18–19, 2002, in Indianapolis. PENNDOT hosted the second workshop on April 10–12, 2002, in Pittsburgh. Both DOTs had special corridors they proposed for consideration as the first pilots.

CHAPTER 3

Indiana Department of Transportation ACTT Workshop

PROJECT DETAILS

Corridor Description

INDOT identified an improvement of I-465 on the west side of Indianapolis from IN-67 to 56th Street. This project included the addition of travel lanes and the major modification of interchanges for the entire west leg. At the time of the workshop, construction was planned to start as early as 2005 but needed to be completed by 2010. More than 150,000 vpd traveled this 12-mi stretch of Interstate. Major traffic generators who would be affected by this improvement include Indianapolis International Airport, Indianapolis Motor Speedway, Indianapolis Raceway Park, Ameriplex Industrial Park, and Eagle Creek City Park.

Corridor Goals

INDOT wanted the ACTT to help ensure that the traveling public would receive a quality product in a timely and safe fashion. INDOT presented the following main goals for the next phase of the I-465 reconstruction:

- Minimize traffic disruption during construction,
- Maintain traffic flow at 45 mph in the construction zone or a minimum of three lanes in each direction,
- Accommodate national and international events,
- Provide access to the airport throughout construction,
- Design and build the project within the estimate of $4 million,
- Construct the project within 3 years,
- Maintain a safe work site,
- Minimize ROW and utility delays, and
- Clear before construction.

Several of the goals were clearly defined and measurable; others would require new approaches.

Project Improvements

The current mainline pavement consists of 6 lanes—three northbound and three southbound—of concrete with asphalt overlay. There are eight interchanges within the corridor—IN-67, I-70, Airport Expressway, US 40–Washington Street, US 36–Rockville Road, 10th Street, I-74–Crawfordsville Road, and 38th Street. There are six main line bridges and nine overpasses. The annual average daily traffic ranges from 94,300 vpd to 152,700 vpd.

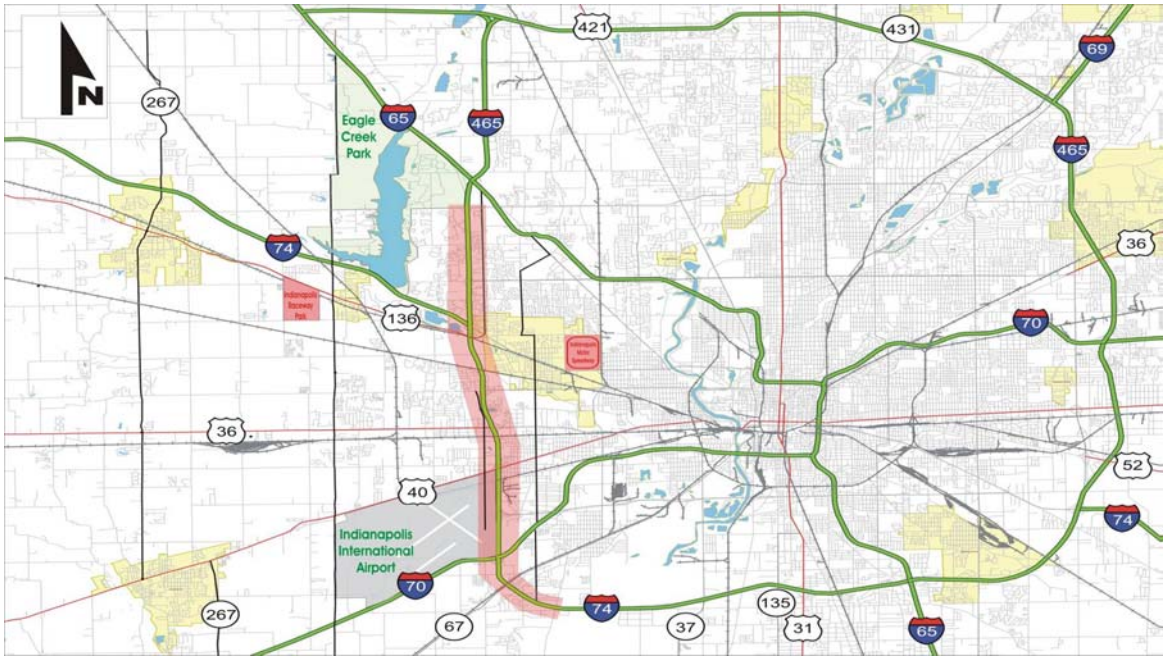

FIGURE 4 West side of I-465 around Indianapolis.

When complete, I-465 capacity will be increased with the addition of one travel lane in each direction. The eight interchanges within the project will be modified to increase their efficiency. Auxiliary lanes will be added along the main-line pavement between interchanges to increase the efficiency of weaving movements and adjacent through lanes. I-465 will then effectively prevail as a 10-lane/12-lane facility, versus the existing 6-lane facility.

Project Status

INDOT's consultant for the project was tasked to complete the phase of work that culminates with what INDOT calls an engineer's report. At the same time, the consultant will be completing an EA that fulfills National Environmental Policy Act of 1969 requirements. The engineer's report provides the direction and scope of work for the planned development phase, which will lead to construction. These work activities were scheduled for completion by September 2002.

At the time of the workshop, the planned development phase was also under way. INDOT was surveying the project corridor. Ground monumentation was being completed so that helicopters could take the photography for low-level aerial survey. The low-level aerial process was being used to increase the accuracy of the aerial photography compared with more traditional high-elevation aerial surveys. Preliminary information from the engineering assessment was to be used to advance the plan development.

Because this construction project will not start until 2005, INDOT plans to add a thin resurface to areas of main-line pavement that are showing distress and that could have major deterioration before reconstruction. This work will be completed as needed.

In anticipation of corridor rebuild, INDOT plans to maximize communication with the public through extensive media and public information campaigns. A contract has been let to construct a 58,000 ft^2 traffic management center (TMC) for the area that will collate traffic management with police personnel and others involved with the freeway service patrol. INDOT

will have access to system detector data via a wireless communication system and will have the ability to change the display on variable message signs (VMSs) to keep motorists informed throughout construction.

Indiana has historically been a "pay-as-you-go" state. However, in the 1990s, Indiana began bonding projects and has gradually moved toward more innovative financing methods. Additionally, the DOT has not let a project of this magnitude before, although the future program shows several additional corridors could approach this size and complexity. INDOT has had limited experimental experience with contracting techniques other than the conventional design–bid–build (DBB) or "low-bid" process.

INDOT WORKSHOP MEETING DETAILS

After several planning meetings, INDOT identified the following skill sets for the workshop:

- Innovative financing,
- Innovative contracting,
- Work zone traffic management,
- Worker health and safety,
- Utilities,
- Long-life pavements,
- Prefabricated and modular construction,
- ROW,
- Traveler mobility (ITS and modal), and
- Constructability.

National experts were identified in each of these categories who could provide (*a*) insight on what is occurring nationally and (*b*) innovative strategic approaches to the corridor analysis. In total, the national team consisted of 23 specialists.

The workshop began with opening remarks from three senior executives: Bryan Nichol, Commissioner, INDOT; Mike Ryan, Assistant Secretary, PENNDOT; and Pete Rahn, Secretary, NMSH&TD.

Bryan Nichol, Commissioner, INDOT

After welcoming remarks, the commissioner urged participants to be as creative as possible and to remain open to any new ways of doing business. INDOT was always looking for alternatives, for a mix-of-fixes approach to these major projects. Although at the time of the workshop INDOT could not commit to moving out with a project of this magnitude, it could commit to being as creative as possible and to identifying the challenges as well as possible solutions. Mr. Nichol promised fair and open discussion of any new ideas that come out of the workshop.

Mike Ryan, Assistant Secretary, PENNDOT

Mr. Ryan presented the background and history of the task force, the November 2000 workshop, and the concept behind the pilot workshops. He emphasized the need for new solutions to

today's construction impact on the traveling public. He also stressed that in today's climate, it is very hard to explain to the public the time it takes to bring corridors on line. Workshops like this one may help to clarify the complexity of at least one facet of the issue—the relationship between construction and traffic management. Finally, he urged participants not to fixate on any barrier to implementation but to focus on a multidisciplinary approach to creating new ideas and synergy to overcome these barriers.

Pete Rahn, Secretary, NMSH&TD

Secretary Rahn discussed the work performed by the NMSH&TD over the last several years. NMSH&TD has developed detailed definitions of major corridors and has established needs, budgets, and strategies to address full corridor needs. One major point raised by Secretary Rahn was setting sound goals for the project. By establishing goals that are clear, bold, and challenging, INDOT may just be at the halfway marker already. He also stated that there will always be challenges from different segments of the industry because change is never easy and always requires adjustments.

Workshop Process

The eight national and state skill set teams then retreated to individual meeting rooms to discuss the key issues. After several hours, the skill set teams met with other skill set teams to discuss overlapping issues. Each group developed an overall summary that was coordinated with the other skill sets.

BREAKOUT TEAMS' IDEAS AND DISCUSSION

Innovative Finance Team

If one skill set was the driver for meeting the INDOT goals, it was the financing of the project. INDOT had not yet programmed the funds for this corridor. The national team introduced an approach early in the process:

- Align the financing options with the goals of the project, especially in the time frame of 3 years;
- Match cash flow management tools to project needs; and
- Recognize the competing project priorities for existing resources.

INDOT examined seven potential financing tools, including various federal-aid fund management techniques, advance construction, and matching options. Matching options could include devices such as tapered match, toll credits, the use of state bond investments as credit for match (FHWA's Test and Evaluation Program TE-45 experimental program), or a soft match. It also examined various cost-sharing strategies, tolling mechanisms, contractor financing, leveraging techniques, credit assistance, and cost management and containment concepts. The leveraging techniques included general obligation bonds, grant anticipation revenue vehicles (GARVEEs), and highway lease revenue bonds. Credit assistance included the State

Infrastructure Bank, a Section 129 Loan, and the Transportation Infrastructure Finance and Innovation Act of 1998 Credit Program.

After a thorough review of these options, members of the national team listed the following ideas:

- Consider the GARVEE bond mechanism as the principal financing vehicle (Table 1);
- Maximize federal matching tools;
- Implement cost containment through procurement strategy, value engineering, and early industry reviews;
- Set a project budget and manage to the budget; and
- Involve other stakeholders in funding.

Membership of the national team then listed supporting principles that would underpin the financing plan:

- Incorporate capital renewal/warranty obligations in procurement—life-cycle cost efficiency and long-term cost predictability;
- Support the GARVEE program with stakeholder involvement in project funding, including the city of Indianapolis, the airport authority, and the speedway;

TABLE 1 Indiana Transportation Authority Highway Revenue Bonds, Series 2004, Financing Alternatives

	Option 1	Option 2	Option 3
Years to maturity	10	12	15
Final maturity	2013	2015	2018
Par amount issued	$319,955,000	$365,855,000	$424,235,000
Estimated funds for projects*	$317,651,324	$363,220,844	$421,180,508
Annual Debt Service, Approximately	$40,000,000	$40,000,000	$40,000,000
True Interest Cost**	4.43%	4.58%	4.70%
Total Interest Cost	$73,470,670	$106,402,628	$166,368,454

*Plus investment earning on proceeds during construction
**Total current interest rates as of March 14, 2002

Dated date:	June 1, 2004
First interest payment date:	December 1, 2004
Maturity:	December 1, 2004, and annually thereafter
Issuer:	Indiana Transportation Finance Authority
Obligor:	Indiana Department of Transportation
Security:	Lease payment biannual appropriations
Payment source:	Federal grant aid revenues
Ratings:	To be determined, expected to be high A or AA category

- Control development costs—do not pass the point of diminishing returns, and do not erode private innovation and efficiency;
- Accelerate the financial plan;
- Emphasize cost containment strategies and economies of scale; and
- Scope out a plan of finance.

To implement the plan, the national team listed the following items that INDOT should consider:

- Development of a comprehensive debt policy—pay as you go versus bonding; gas-tax–backed bonds; and GARVEE bonds backed by future federal funds, including the authority to issue GARVEEs;
- Examination of the project's annual cash flow requirements and definition of the boundaries; and
- Attainment of funding for the ROW and development costs. The costs for these activities could be rolled into the construction and bond finance total project costs or with currently programmed funds.

Innovative Contracting Team

The innovative contracting team set the course for the design and construction issues for a project of this magnitude. The team discussed in depth the delivery of the design and the construction, both as separate issues and as a package. INDOT has experimented with DB; it is controversial within many segments of the construction and engineering professions.

Members of the national team listed the following three options, including suboptions:

1. DB with two suboptions:
   - Option 1. Total project DB package, which includes early start for items not affecting main-line traffic and long-term warranties as well as all main-line work.
   - Option 2. Partial project DB package, which addresses early items not affecting main-line traffic. This would be followed by a DBB for the main-line traffic impacting work, using a multiple combination contract (apparent low-bid combination).
2. Negotiated contract for design, construction management, warranties, and bid-out construction; bid-out construction could be multiple apparent bid combination.
3. Bid-out construction at a biddable percent of design; contractor would be involved in remaining design considerations.

For all three options, INDOT could

- Explore legislation issues;
- Market the project early and continuously;
- Initiate a public awareness campaign in the contract;
- Define the management group and structure;
- Establish incentives and disincentives for design and construction firms tied to all project goals—cost, time, quality; and
- Establish the maintenance of traffic parameters:

- Designate the number of lanes maintained or the required traffic speeds,
- Specify ramp closure periods, and
- Integrate clearly with event status.

The DB process for early design work not affecting main-line traffic would include utilities, sound walls, lighting, bridge fabrication, and so forth. Where feasible, ITS infrastructure—both along the main line and along key regional and local alternative routes—and local street operational improvements also could be included as part of any early design work to provide increased roadway capacity and to facilitate the management of local and regional traffic diversions.

The apparent low-bid combinations allow for single or total bid acceptance on the basis of the sum of low bids. Included in the package is a bid item for cash flow converted to present worth. Whatever technique is finally adopted by INDOT, the concept could be marketed to the contracting community to ensure that it is involved and knowledgeable. The technique also can allow for materials to be procured (or at least planned for) early in the process.

Traveler and Mobility ITS Team

This team had significant discussions on a wide range of issues, including ITS, transportation demand management (TDM), IM, local street diversions, operations and improvements, and public awareness. In addition, traveler mobility and ITS issues interrelate with and can be considered when assessing requirements for the following skill sets:

- Innovative contracting,
- Constructability,
- Modular and prefabricated bridge systems,
- ROW,
- Worker health and safety, and
- Utilities.

Members of the team suggested defining maintenance of traffic policies and key requirements early in the process and identifying what is politically attainable. The DOT could set key policies and develop an implementation approach. For example, keeping traffic on I-465 dictates an aggressive IM program, whereas closing multiple main-line lanes dictates the pursuit of aggressive TDM and local street operation improvement strategies.

Some team members also suggested completing a pre-main-line closure construction contract(s) before initiating the main-line work. This would include completing route improvements and operational fixes on the local system, including signal system improvements within the I-465 corridor's area of influence. They also suggested deploying as much future ITS as possible on the main line and along identified regional and local alternate routes to support incident and traffic management functions during the construction period. It also could be effective to implement ramp metering in conjunction with acceleration lanes during construction to balance traffic flows and to increase main-line capacity. The use of an ITS contractor–systems integrator could help to minimize deployment costs and to maximize the construction schedule. Team members also listed

widening the median bridges and building structures that span the main line to maximize the potential pavement width, the number of potential travel lanes, and the shoulder widths during the construction period for the purpose of maintaining capacity and facilitating IM response personnel in a timely and organized fashion.

Some members suggested a public awareness and TDM initiative that would include establishing partnerships with a public relations firm and the INDOT public affairs office. The DOT could identify customers, proactively reach out to them early and often, and speak directly to all customers. It might be advantageous to establish a transportation management association (TMA)[1] to work with employers and commuters to identify alternative commuting options. Some other issues listed included marketing a suite of TDM alternatives such as telecommuting, transit, carpooling, park and ride, flextime, and financial incentives. The marketing of the INDYGO transit system could be improved, and incentives for telecommuting could be provided.

A key to construction mobility will be the deployment of a construction zone IM plan. This plan could help integrate and expand the use of the INDOT Traffic Wise program. To facilitate IM response and clearance in a timely and organized fashion, full shoulders could be provided on the mainline. Where shoulders are not available to provide a safe haven for disabled vehicles and motorists, emergency pull-off areas every ½ mi could be established. Additional items listed include (*a*) developing IM staging areas so the emergency response community can stage major response efforts without blocking additional travel lanes, (*b*) using the INDOT Traffic Wise program instead of the contractor to provide the IM, (*c*) using photogrammetry in lieu of total station units to quicken the clearance of major incidents, and (*d*) providing tabletop training for the incident and construction management community.

Constructability Team

One of the most important elements of a project of this magnitude is developing a mechanism by which contractors have a say in how the project can be built effectively. This mechanism allows feedback on those design elements that would significantly affect time or quality during actual construction. Constructability team members came up with the following ideas for consideration:

- Use a pre-main-line contract to complete all work items that do not affect traffic, before initiating the traffic impacting work items.
- Conduct an intensive utility survey to minimize the risk by both parties. If possible, the parties should consider hiring an outside entity (not the DOT or the design contractor) to conduct and manage the utility work. If possible, develop ways that the contractor can be involved in moving the utilities.
- Develop a collaboration process—contractor, utilities, ROW, designers (emphasize traffic control), DOT construction engineers, and local agencies. This could help minimize any misunderstandings and expedite the change approval process.
- Establish an innovation process that provides more incentives. This could maximize the opportunity and acceptance of innovation, maximize access to work areas, and maintain flexibility throughout the process. The DOT should consider designer incentives as well. For example, it is possible to pay the designer in phases on the basis of quality of design, including appropriate incentive fees. The NMSH&TD has documentation.

- Increase attention to quality by improving the quality incentives. Although there are incentives for discrete product attributes such as pavement smoothness, admittedly there is no universal standard for determining overall project quality, other than possibly a warranty. Other factors could be considered for incentives—safety, traffic movement efficiency, and so forth. To improve creativity and innovation, it was also suggested that the value engineering reward level be increased above the 50–50 split and include more incentive for time-based solutions.
- Use DB in lieu of DBB. From a constructability standpoint, the contractor has much more input in DB. This point could be considered strongly in a project of this magnitude. The DOT could strive for optimizing project packaging by using clustering or sequential techniques or by creating one major project for design and one major project for construction.
- Use an enhanced contractor prequalification process. INDOT could investigate contractor prequalification, on the basis of Kentucky Transportation Cabinet experience. This may take legislative approval in Indiana and, admittedly, may be quite controversial. The process should include a quality factor in the selection process.
- Include A + B and lane rental concepts throughout the project. If these work properly, they could minimize lane restrictions.
- Investigate all the night work issues, including local noise ordinances, and seek relief. This investigation could lead to ideas that could advance contractor innovation in night work strategies. The DOT also could ensure special considerations for worker and public safety. To minimize night work, the DOT could allow as much material access as possible during the day to eliminate night work.
- Develop a planned issue resolution process. The North Carolina DOT has documentation that may be appropriate.
- Investigate all processes and materials that have weather restrictions and look for rational alternatives. Weather-related restrictions include items such as minimum paving temperatures, seasonal shutdown dates, and so forth.
- Examine the documents to determine the delivery time required for certain materials requiring a long lead time. Either alternative material sources or early procurement, especially for bridge components, could be considered.
- Optimize bridge and retaining wall standardization along with modular and precast concepts.
- Address staging areas in the contract, especially if ROW is needed.
- Coordinate waste removal and disposal from the project site with other Indiana state or city jurisdictions if the material cannot be used on site.
- Pay particular attention to the contractor QC program to ensure it will be thorough and to prevent errors.

Long-Life Pavements Team

"Staying out" is a major factor for the overall success of the project. For high-intensity projects such as this, it is feasible to look at pavement designs that push the 60-year envelope. Many members of the team agreed that telling the contractor what the DOT wants, not how to build the pavement, is critical to getting a sound final product.

The team discussed design life for the pavement and focused on a 60-year design life.

However, a 60-year design is not necessarily a "build-and-forget" pavement; the technology is not that advanced. It is possible, though, to design and build a 60-year pavement that has continuous service with some maintenance but without a major rehabilitation. The team defined a major rehabilitation as one that requires a maintenance technique that interrupts peak hour traffic. Members of the team came up with the following ideas for consideration:

- Ensure that the pavement performance goals and objectives for the project are clearly identified and communicated to the designer and contractor, allowing the maximum freedom to determine methodology.
- Provide the contractor with all pavement design inputs—traffic information, environmental information, and available and preferable materials to the contractor.
- Consider one of the following four different pavement delivery techniques that address the pavement type selection and design options; each technique transfers more responsibility from INDOT to the designer and contractor:
  - Option 1—Traditional (INDOT selects pavement and designer; contractor builds);
  - Option 2—Design, build (state selection);
  - Option 3—Design, build, maintenance warranty (contractor option for design with a 5-year maintenance warranty); and
  - Option 4—Design, build, maintenance warranty (contractor option for design with a 10-year maintenance warranty).
- On the basis of current design procedures, use the following as guides of what pavement type might be ultimately designed:
  - Sixty-year portland cement concrete (PCC)—18 in. plus 1 in. for diamond grinding preventive maintenance;
  - Sixty-year asphalt cement concrete—mill and fill (1 to 1½ in.) (preventive maintenance); and
  - Composite 60-year PCC with 4-in. stone mastic asphalt—mill and fill (1 to 1½ in.) (preventive maintenance).
- Use a typical pavement width of 88 ft, including a 12-ft outside shoulder and a 16-ft inside shoulder.
- For the pavement below the frost line, incorporate underdrains in all designs, and include positive surface drainage across the pavement.
- Regardless of the pavement type or design, the work could be performed within the following parameters as they relate to pavement construction:
  - Establish a traffic plan that allows no more than a 1½ in. drop-off for safety during construction;
  - Maintain traffic flow at 45 mph (or whatever standards are set for the project); and
  - Use cost plus time plus quality (A + B + Q). Quality incentives could be revisited to ensure balance and equity with time.
- Use lane rental to quantify any maintenance activities that would be required during the maintenance warranty period, should it be selected (see Option 4 above). This could mean that if any repairs to the pavement are required, under a predetermined set of conditions, INDOT would charge the contractor $60,000 per day per lane for lane rental (on the basis of true user costs). However, if the repairs or maintenance could be done during

off-peak hours, the lane rental would drop to $3,000 per lane. These numbers would need to be determined for specific projects' values.

- Measure pavement performance by four parameters:
  - International roughness index (IRI),
  - Friction,
  - Cracking (longitudinal and transverse), and
  - Rutting and scaling.

These four factors can be woven into (*a*) pavement design, (*b*) pavement construction acceptance, (*c*) pavement maintenance requirements, and (*d*) pavement turn back requirements after the warranty period.

Modular and Prefabricated Bridge Systems Team

Members of this team discussed three concepts that could help to build the project more efficiently and could reduce quality problems.

Standardization of Designs for Full Project Limits

Standardization of the design includes (*a*) creating standard span lengths, beam types, beam spacings, and so forth, for use throughout the project to the greatest extent possible; (*b*) using a single designer for all bridges; and (*c*) using segmental or other prefabricated unit construction for flyovers. However, the effect on aesthetics could be a concern. Also, because of standardization of the span lengths, the structure may not fit the site—it may be longer than necessary, which may result in additional material costs.

The concept of prefabrication is based on the idea of fabricating as many of the structural components off site as possible. These components are then brought to the bridge site and assembled. In modular construction, repetitive structural units are used to create the completed structures. These modular units may be prefabricated or may be fabricated on site.

Prebuilding: Widening and Lengthening Overpass Bridges First

Prebuilding could help reduce the traffic interruption time. This method also could include the prepurchase of materials as part of the effort. Prebuilding eliminates the need for prefabrication or modular construction. This technique requires early and careful coordination with utilities. There is also the question of the cost-effectiveness of this effort because it requires mobilization costs for two separate contracts. All prebuild issues interrelate with traveler mobility, ROW, contracting, and finance and must be included in the front end of project development.

Large Component Assembly

Large component assembly consists of building and lifting into place complete span units, piers, caps, and so forth or erecting beams in groups with the slab placed later. This technique can reduce the time for lane closures. The repetitive nature could improve contractor productivity. The current disadvantage is that the direct project costs may

increase. User costs must be considered to determine cost-effectiveness. The overall savings and benefits of this technique are, in part, dependent on industry experience and volume of work required.

Several states are aggressively evaluating precast deck panels. Texas DOT has a significant amount of information on this topic. Precast technology has proven to be much faster construction with less disruption to traffic on the roadway below. The only disadvantage is that a number of states tried this technique many years ago, and it carries a "we tried that before and it did not work" stigma with it.

In addition, an entire temporary bridge may be brought in for project needs and removed after the operation is complete. Essentially, the contractor leases the bridge to the DOT. It does not cause much interruption to the traveling public. However, additional ROW may be required, and tight urban conditions may make this solution impractical.

Members of the team did not discuss a specific design life. However, they did discuss making use of improved products and emerging technologies that could provide longer life structures, such as high-performance concrete, self-compacting concrete, steel with improved corrosion resistance, and other high-performance steels. There is a learning curve, and, although there are high hopes for these emerging technologies, these technologies are not proven as yet, and the costs are still uncertain.

Although not directly a bridge issue, members of the team noted that Texas DOT is experimenting with precast–posttensioned concrete pavement slabs. It may be possible to tie to specific bridges for short sections of pavements. Obviously, this technique is not currently

FIGURE 5 Precast deck panel construction.

cost-competitive with traditional construction. It does not circumvent the weather and may be better suited for rehabilitation strategies.

Timing and coordination of the structural work are also important. Members of the team offered the following ideas for enhancing operational needs:

- Build the bridges as early as possible in the project.
- Replace all bridges with the objective of "staying out."
- Standardize bridge designs.
- Involve contractors earlier in the design. This is of particular importance if a prefabricated system is used.
- Consider segmental construction for flyovers.

Members of the team also listed the following ways to integrate bridge operations with ITS and mobility, utilities, and financing:

- Examine complete closure of the overpass bridges.
- Examine elimination of the center pier, which resulted in a 200-ft span, for traffic flow.
- Check the expense and construction speed of crossover bridges, because these may be a concern.
- Temporarily shut down main lanes at night to set girders.
- Recognize that nothing happens until the utilities are moved. Do not assume that the utilities must be carried across the bridge.
- Include payment in the finance plan for prefabricated members before they are delivered to the job site.

ROW Team

Historically, the ROW discipline is on the outside of the planning process and is called in "when needed." The workshop allowed the ROW discipline to interact with other skill sets early and to provide them with a real estate perspective for this project. Under normal situations, the following timeline would apply:

- INDOT would finalize the EA/finding of no significant impact (FONSI) for the corridor in 2002.
- ROW would then begin preparing abstracts, descriptions, and appraisals, which are estimated to take approximately 16 months. In reality, it is more likely to take 24 months for the corridor and may take upward of 36 months.
- Offers would be made around the middle of 2004.

ROW team members believed that the following ideas, if implemented, could reduce overall project delivery time by 1 year. The focus is on allowing ROW work to proceed sooner with fewer revisions and rework. Title and abstract work would start before the EA/FONSI is finalized. The first major time-saver is to set a generous ROW limit now. A second major time-saver involves developing the utility easement needs at the same time.

- Use an integrated project development approach with a project manager and set the project schedule as soon as possible. This is necessary for both the ROW and utility sections to do resource planning. They also may benefit from the formation of a team concept—ROW, utilities, and the design team that will coordinate issues and needs as early as possible.
- Set the ROW limits now using a generous approach and assuming an open drainage system. Detailed design can continue within these "generous" ROW limits. That way, the utility and ROW sections can coordinate and begin working on abstracts, descriptions, appraisals, and acquisition even though a final design is not complete. This could speed up ROW clearance by as much as a year. This is not to say that ROW will never go back to an owner to increase the acquisition later. That is one of the risks with this process.
- Coordinate with legal to get the necessary statutory authority to purchase whatever land is needed in conjunction with a highway project. This includes land needed for environmental mitigation and utility relocation. Although this legal authority may not be available in time for use on this corridor, it is needed for timely delivery of future projects.
- Coordinate closely with utilities to determine whether the ROW section can assist in acquiring the necessary utility easements. If the DOT or contractor can make the contact for both ROW and utility needs, it means dealing with the property owner once. FDOT has language available to use.
- Focus first on the parcels that will require more time for difficult relocations. Work on these acquisitions can begin before final design is complete when the ROW limit is set early. Parcels near the airport can be left for last to avoid conflicts with the scheduled airport expansion.

Additional notes from members of the ROW team included the following:

- If 100% state funds are used to acquire some parcels, these funds can be used as a credit toward the required project match.
- The DOT may be interested in developing a pilot project and may request FHWA approval to use an acquisition incentive payment. These funds are above the offer and do not count against the relocation payment. They are a bonus for signing before the parcel is filed for condemnation. FDOT is using an FHWA-approved schedule on a pilot project in three Florida districts.
- The DOT also could develop a pilot project and request FHWA approval to use a relocation incentive payment. These funds are over and above the relocation payment offer and are tied to specific time frames. The Virginia DOT also can provide an example.
- If INDOT decides to go with DB contracting, it could include ROW acquisition in that contract.
- For the long term, work on getting legislation to approve "quick take."
- Outsourcing condemnation could expedite work by the Indiana attorney general. This would consist of letting a contract to have condemnation documents prepared for the attorney general, making payments for the attorney general to hire outside counsel, and making payments to help expand the court system to alleviate delays.

Members of the ROW team know there needs to be a mindset to not "minimize" ROW acquisition around the country. INDOT stated as much for this project. History shows it was a cost-containment idea that started in the Interstate era. Many members of the ROW team do not believe that the ROW costs are that great compared with overall project costs or the cost of a year of delay. In addition, residences are often left that should be acquired. The profession gets caught up in an effort to acquire the perfect amount of land and sometimes loses sight of the need to deliver the project to reduce congestion and to build a safer roadway now. Under normal circumstances, the design team, with ROW input, could set a generous ROW limit early. Changing how and when ROW limits are set could help ROW sections around the country. This has the potential to speed up project delivery on all projects, not just special projects. Although this concept appears simple, it is not. It requires major rethinking by every person involved in developing a project, including those working on the EAs. When all is said and done, however, there are times when the ROW needs must be examined carefully, particularly with regard to very high-cost areas and sensitive areas that have environmental or historical significance. In these cases, ROW acquisition will have to wait for final design.

Worker Health and Safety Team

Worker health and safety is a growing concern on all projects, especially those with major accelerator clauses included.

The worker health and safety team members identified the following considerations:

- All safety issues should be addressed and integrated with the constructability reviews discussed earlier.
- Safety should be fully integrated with the traffic management plan. Of particular concern are night work illumination and pavement issues. To this end, there could be a site-specific safety and health plan with singular responsibility of one person on the contractor staff.
- For the traveling public, safety should be linked to the public awareness program mentioned in the traveler mobility sections.
- Although there are few specific highway data on the relationship of worker fatigue to safety, the long arduous hours under accelerated construction conditions may dull the effectiveness of workers, for both the contractor and the inspection forces. The contract documents require forced and scheduled time off the project. This time off can be integrated with speedway and raceway traffic generator events. In addition, worker access to the site can be controlled through satellite parking and busing to the specific work area.

Utilities Team

The overall goal is to have minimum impact on the construction contract and on the traveling public. The most common problems are as follows:

- Improperly located or unknown utilities,
- Timeliness of relocation of utilities,
- Upgrade of utilities,
- Designing of project to avoid utility conflicts, and
- Timely ROW acquisition for project and utilities.

The utilities team suggested the following:

- Subsurface utility exploration (SUE) could be used to obtain better information on utility location and potential interference. The key design issues are to identify ROW constraints and conflicts and to identify what can be designed around them. INDOT and utility ROW easement could be procured at the same time. Those utilities that can be moved early could be identified. Those that cannot be moved could be put in the main contract with contractor responsibilities clearly distinguished.
- There should be no new or changed permits during design without proper coordination. The project could be designed using 3-D computer-aided design, taken from the utility locations identified by SUE to avoid relocation.
- There should be clear incentives and disincentives to the design team to locate and address all utilities.

INDOT WORKSHOP CLOSURE

INDOT thoroughly evaluated all the ideas and has adopted many of them in its long-range planning. Several of the key concepts that are still evolving are as follows:

- The DOT believes that the most critical item related to meeting the project schedule is the ROW. INDOT has had significant concerns in accelerating ROW. Additionally, the work start may slip until 2007 because of other needs around the state.
- The concept of requiring a performance-based traffic goal of 45 mph through the work area is worth exploring, but the DOT has no (*a*) contract language, (*b*) quality measurement tools, or (*c*) experience with managing such a concept. INDOT believes it is more practical to require a minimum of three lanes in each direction. Currently during peak hour, the traffic does not attain the 45 mph goal without construction under way.
- The DOT was impressed with the financial plan and believes the national team did a fine job in defining the options. Because legislative approvals are required, it is not a simple path.
- The DOT believes that multibid award would probably work better for this project. Most of the design is fairly straightforward and can be accomplished before bidding of work, even with a 2005 start date. The DB concept has been tried before and has not been welcomed by the industry.
- The DOT also expected that perhaps four engineering contracts would be required to handle the design work. The DOT plans to award all four, even though the national team recommended one major contract with some control of subcontract design work. The lead designer in essence would work as the coordinator, filling roles classically filled by DOT staff. The DOT believes this may happen, but a number of issues need to be resolved.

Overall, INDOT was very pleased with the ideas provided by the national team. It believes that the project could be built in 3 years, which is, after all, the major thrust of the review. The ACTT concept is something INDOT may replicate on other projects.

ENDNOTE

1. In Delaware, this is a pseudo public–private agency funded by companies that sign up for services from the TMA. These services include setting up ride share partners, educating the public about alternative travel programs, and establishing congestion management update centers within a business site and between various sites located within a similar region. Additional services of the TMA include the HomeFree Guarantee Ride Home program, the School Pool program, Wage Works Programs, tax incentive plans for individuals and employers using alternative travel programs, and so forth. Its budget is partially funded by the state's transit organizations, that is, Dart First State also pays for maintaining the TMA program in Delaware.

CHAPTER 4

Pennsylvania Department of Transportation ACTT Workshop

PROJECT DETAILS

Pennsylvania Project Description

PENNDOT was contemplating an improvement of PA-28 from Chestnut Street in the city of Pittsburgh to the Millvale interchange in Millvale Borough. PA-28 is a limited-access principal arterial serving as a major interregional transportation facility connecting the communities in Armstrong, Butler, Clarion, and Jefferson Counties with I-76 (Pennsylvania Turnpike), I-279, I-579, the city of Pittsburgh, and Pittsburgh International Airport. PA-28 is a limited access facility for its entire length except for the subject section to be improved, which is an approximate 2.8-km (1.8-mi) segment from 500 m (1,659 ft) west of I-579 near Chestnut Street to the Millvale Interchange. Proposed improvements include elevating and bifurcating PA-28 to accommodate widening to four 12-ft lanes with shoulders and median barrier, providing grade-separated interchanges at the 31st and 40th Street Bridges, and realigning Rialto Street to a "plus" intersection with the 31st Street Bridge. On average, more than 60,000 vpd travel this section of PA-28.

PENNDOT Traditional Construction Procedures

PENNDOT's traditional approach to a project of this magnitude would be the following:

- Let at least two, if not more, construction contracts;
- Maintain at least two travel lanes in each direction during construction (35 mph desirable);
- Provide a construction budget of $140 million; and
- Undertake construction from 2007 to 2010.

Allowing for a construction start in 2007, the following deadlines would have to be met:

- March 2002—predraft environmental impact statement (EIS) submitted to the district;
- May 2002—draft EIS submitted to central office and FHWA;
- May 2003—record of decision (ROD);
- Fall 2003 through fall 2006—ROW acquisition;
- May 2004—design field view submission (30% design);
- Fall 2006—final design;
- Spring 2007—construction notice to proceed; and
- Spring 2007 through fall 2010—construction.

FIGURE 6 Overview of existing PA-28.

PA-28 Budget

The following budget was established for the construction:

Phase	Amount (000)	Year Programmed
Design	$4,120	2003
ROW	$1,500	2003
ROW	$15,500	2004
Utilities	$200	2005
Utilities	$1,400	2006
Construction	$140,000	2007–2010

PENNDOT Goals

In an attempt to accelerate the corridor and to alleviate the congestion in the area, PENNDOT wanted to explore with the national team the possibility of meeting the following corridor goals:

- Complete construction in 2 years,
- Reduce date to bid from fall 2006 to fall 2005,
- Maintain traffic flow of 35 mph during construction,
- Expedite ROW acquisitions and utility relocations,
- Be customer- and neighbor-friendly during construction,

- Provide long-life pavement—50 years without a major maintenance cycle,
- Facilitate railroad coordination, and
- Build a project that is aesthetically acceptable and constructable.

The project-needs statement identified several factors that require improvements to this segment of PA-28, including capacity, safety, system linkage and continuity, design issues, and compliance with comprehensive transportation planning. The improvements to PA-28 will save approximately $11 million per year in users' delay cost.

The project segment of PA-28 is a four-lane, undivided, free access highway with at-grade intersections and drive accesses. Traffic analyses show the average daily traffic ranges from 56,000 vpd at the southern end of the project to 70,000 vpd at the northern end. The truck percentage ranges from 7% to 9%. This section includes four signalized intersections, narrow lanes, and a tightly confined corridor. The roadway is supported by a retaining wall adjacent to active railroad tracks along the northbound lanes as well as development, including numerous historic resources, residences and businesses, and a church adjacent to the southbound lanes.

The project is currently in Step 6, preliminary engineering, of PENNDOT's 10-step project development process. PENNDOT has a consultant under contract to complete preliminary engineering studies. A predraft EIS was prepared on the basis of the most current information, and the draft EIS is being submitted for review in March 2002. An ROD is anticipated for June 2003. A consulting firm will be retained to complete final design of the project following the ROD.

Shortened time frames for completion of engineering and environmental studies, ROW acquisition, utility clearance, permits, and final plan development are the rule when accelerating construction projects. Project management and scheduling will be critical elements in achieving the scheduled letting dates for the project.

As stated earlier, PA-28 carries a high volume of traffic. Traffic typically has a southbound peak during the morning peak hour and a northbound peak during the afternoon peak hour. The corridor also experiences increased traffic volumes as the public commutes to and from professional hockey, football, and baseball events; the Three Rivers Regatta; the Three Rivers Arts Festival; and other sports and cultural events in the Pittsburgh area. Few alternative

FIGURE 7 St. Nicholas Church.

routes can be used to reach the destinations for the travelers along this corridor. The alternate routes all involve two-lane facilities in residential or commercial areas, and most are congested already. Maintaining traffic flow along PA-28 during construction will be necessary to minimize traffic impacts during construction. Alternative means of reducing or improving traffic flow during construction are needed.

As for ROW issues, the project will affect more than 200 properties and include relocation of some residences and businesses. A park, a cemetery, an industrial park, and historically eligible properties, including St. Nicholas Church, will be affected as well. The church is currently eligible for inclusion in the National Register. Alternatives would either relocate the church or perform recordation and demolition of the church. Acquisition of approximately 239 properties will be required for this project. Most of the parcels will be total takes, not requiring the relocation of a business or residence. PENNDOT is proceeding with appraisals and making offers to properties that qualify for hardship acquisition. Nine hardship properties have been acquired. PENNDOT also is planning to begin ROW incidentals (e.g., appraisals) in October 2002 before the ROD in an effort to expedite ROW acquisition.

The project scope requires the improvement of a 2-mi section of East Ohio Street between Millvale and the H. J. Heinz Plant in Pittsburgh. The project scope includes the preliminary design of two new interchanges at the ends of the 31st Street and 40th Street Bridges, which cross the Allegheny River, and new limited-access northbound and southbound lanes. The narrow corridor is between the Norfolk Southern Railroad property and a steep hillside, including rock cliffs, that supports the Troy Hill neighborhood of Pittsburgh. Additional constraints include two churches designated as historical landmarks, old service station sites, a cemetery, and an industrial park. The PENNDOT consultant expects the project to involve 5 bridges with 21 substructures, 18 retaining walls totaling 5 mi in length, 8 rockfall fences, and 3 landslide-prone slopes. Construction phasing and temporary support required to maintain traffic lanes during construction require detailed evaluation. The wall design, which is complex because of the weak bedrock of the Pittsburgh redbeds, will be additionally complicated by the construction sequencing. Because of the urban setting, the subsurface investigation will be complicated by traffic, environmental hazards, utilities, railroad property, and ROW. A critical consideration of the project is the relocation of existing utilities. Utilities located within the project corridor include an existing 60-in. waterline with numerous supply lines; extensive sanitary sewers, including an interceptor line; natural gas supply lines, including a 20-in. transmission line; and electric and telecommunication lines. The existing sanitary sewers are a combination sanitary–storm water system that will have to be separated. The existing combination system could be maintained to carry the existing sewerage, and the new highway storm water system will require new outlets running under the railroad and trail to the Allegheny River.

A Norfolk Southern Corporation railway line is immediately adjacent to the project between the highway and the Allegheny River. Close railroad coordination will be required of the project for construction access and for new storm water or sanitary sewer lines that will have to run under the railroad.

Contractors will have significant challenges with the construction of this project. Contractors will be pressed to deliver a quality product in confined quarters, including working on steep and unstable slopes, while maintaining traffic flow. Completion dates and maintenance of traffic will be very visible to the traveling public. Pittsburgh does not have a local roadway network serving the Allegheny Valley that provides good north–south parallel access adjacent to

the project. The local roads are one lane in each direction and have parking on one or both sides of the road with many intersections and driveway access. Motorists seeking alternate routes around the construction will affect the local network. One of the project challenges is to implement methods to reduce the amount of traffic diverted to local streets.

ITS technologies are in place for much of the Interstate system in the Pittsburgh area. This system is controlled from the TMC adjacent to the PENNDOT District 11–0 office in Bridgeville. ITS applications could be considered for maintaining traffic during construction or for possible inclusion in the project.

Local coordination will be extremely important. The metropolitan planning organization for this project is the Southwestern Pennsylvania Commission (SPC). SPC will be involved in the planning, funding, and scheduling of the project. Coordination with the city of Pittsburgh and the borough of Millvale will be ongoing throughout the life of the project.

I-279 southbound is an important highway for PA-28 traffic to downtown and to Pittsburgh International Airport. Currently there is no direct connection from PA-28 southbound to I-279. PENNDOT is studying the feasibility of constructing this missing link between these two important corridors.

PENNDOT WORKSHOP MEETING DETAILS

In planning sessions before the workshop, the DOT selected the following skill set areas for the ACTT workshop:

- Geotechnology,
- Innovative contracting,
- Utilities,
- Constructability,
- Prefabricated and modular construction,
- Long-life pavements,
- Traveler mobility (ITS and modal) and work zone traffic management,
- ROW, and
- Worker health and safety.

The workshop began with opening remarks from four senior executives: Mike Ryan, Assistant Secretary, PENNDOT; Gary Hoffman, Chief Engineer, PENNDOT, and Chair of AASHTO's Technology Implementation Group; Ray Hack, District Engineer, PENNDOT; Don Lucas, Task Force on Accelerating Innovation in the Highway Industry, Chair, and former Chief Engineer, INDOT.

Mike Ryan, Assistant Secretary, PENNDOT

Mr. Ryan welcomed the participants to the workshop. He noted that this effort, with so many experts from both inside and outside of Pennsylvania, is unprecedented in its scope. This corridor is probably one of the most difficult and at the same time one of the most challenging in the entire state. He urged all participants to be as creative as possible and stated that PENNDOT was very serious in looking for ways to bring corridors such as this one to full service in less time.

Gary Hoffman, Chief Engineer, PENNDOT, and Chair of AASHTO's Technology Implementation Group

Mr. Hoffman also welcomed the experts to the workshop. He expressed his belief that many new ideas would be generated in this effort and that PENNDOT was ready to follow up on them. He also told the audience that accelerated construction was one of the three topics chosen for national technology transfer to all the states. The two pilot workshops—here and in Indiana—would be the foundation for promotion around the country.

Ray Hack, District Engineer, PENNDOT

Mr. Hack presented the background on this particular project and its long history. He stated that he is hoping to generate as many new and innovative ideas that the participants can present. Mr. Hack stated that all suggestions would be pursued and fully evaluated.

Don Lucas, Chair of Task Force on Accelerating Innovation in the Highway Industry and former Chief Engineer, INDOT

Mr. Lucas presented the background and history of the A5T60 Task Force, the November 2000 workshop, and the concept behind the pilot workshops. He emphasized the need for new solutions to today's construction effect on the traveling public. He also stressed that in today's climate, it is very hard to explain to the public the time it takes to bring corridors on line. Workshops like this one may help to clarify the complexity of at least one facet of the issue—the relationship between construction and traffic management. Finally, he urged the participants not to fixate on any barrier to implementation but to focus on a multidisciplinary approach to creating new ideas and generating the synergy to overcome these barriers.

Workshop Process

The nine national and state skill set teams then retreated to individual meeting rooms to discuss the key issues. After several hours, the skill set teams then met with other skill set teams to discuss overlapping issues.

BREAKOUT TEAMS' IDEAS AND SUGGESTIONS

Geotechnical Team

The geotechnical team addressed several of the most difficult technical issues associated with this project. It identified six major issues that need to be addressed, several of which affect the other skill set decisions:

- Understanding the retaining wall complexities,
- Identifying adequate backfill materials,
- Designing and constructing the structural foundations,
- Developing and implementing a strong construction quality assurance (QA)/QC review,

- Defining specifications, and
- Selecting the proper contracting procedures.

The development of the construction sequencing, with all other work predicated on the wall construction, is key to the project. Members of the geotechnical team identified the following sequence of operations:

1. Construct the southbound walls first.
2. Route traffic temporarily onto existing lanes during the first year of construction.
3. Shift traffic along the completed wall during the second year.

Members of the geotechnical team offered the following ideas:

- Consider using soil nail walls to replace a conventional wall in cut sections. Soil nail walls could save time, are more economical, have a built-in redundancy, allow for smaller equipment to be used in the constrained corridor, and do not require excessively deep foundations. PENNDOT has no experience with soil nails in the district and could conduct some experimental work before the PA-28 work.
- Consider using mechanically stabilized earth (MSE) walls. MSE walls are economical and can save time. However, PENNDOT has experienced some high costs on previous projects—this may be a barrier to using them. PENNDOT may need to conduct a thorough examination of the specifications to try to isolate the high costs. MSE design may be modified by reducing reinforcement lengths, which minimizes excavation requirements and costs. Modified MSE will require project-specific testing. This is not common practice in PENNDOT, and it will require some advance experimentation to show benefit to PA-28.
- Consider using MSE walls and reinforced soil slopes as temporary structures necessary for maintenance of public traffic and for construction access. The industry-accepted practice is to have the contractor design the temporary structure.
- Consider wasting the excavated material because it does not appear suitable for fill material. Its removal may affect the schedule and the public traffic.
- Consider using flowable fill as a means to backfill trenches at an accelerated pace without loss of lateral support. It may be worth the extra cost.
- Investigate the use of high-capacity driven piles. They may reduce the risk of removing contaminated soil, are economical, and are easy to inspect. They also pose less risk to potential aquifer contamination.
- Explore the use of lightweight fill that can reduce foundation settlement, provide a quality subgrade, and support accelerated construction. It is important that high-quality material be specified for use as subgrade material to ensure pavement longevity; special placement and compaction will be critical to quality. Price needs to be considered because lightweight fill has been quite expensive historically.
- Consider using performance-based specifications for the geotechnical work. These allow for greater contractor flexibility; however, they require a higher level of coordination with other project activities.
- Consider using DB contracting for faster construction start-up, early involvement by the contractor in proposal development, performance requirements, and QA/QC review. In addition, explore warranty and performance requirements of the wall system after completion of

construction. Regardless of the contracting mechanism selected, there is a need to establish an aggressive QA system and to set project requirements high for cut slopes and walls.

Innovative Contracting Team

The innovative contracting team examined several design and construction issues for a project of this magnitude. The team discussed the delivery of the design and the construction, both as separate issues and as a package. It should be noted that PENNDOT has experimented with DB; it is still controversial within many segments of the construction and engineering professions.

The team examined four options:

- DB,
- A + B + other factors,
- Construction management at risk, and
- Traditional multiple construction contracts.

In the DB option, PENNDOT would be responsible for overseeing quality, assigning fair risk to either party, and setting the overall standards. The contractor would provide the creativity needed for a project of this complexity. The scope of the work would include ROW, utilities, and site investigation. It was suggested that the award use best-value criteria and that only one contract be let for this corridor.

The team identified a series of potential advantages to the corridor if DB is elected:

- A reduction in project delivery time;
- A possible reduction in overall design and construction costs;
- A selection process that would allow for best-value selection, thereby looking at trade-offs from one technique to another;
- A strong encouragement for innovation;
- A better description of end result and final product performance;
- A better integration of constructability into the process;
- A vehicle of extended and comprehensive warranties;
- A faster project decision-making process;
- A reduction in PENNDOT staffing requirements; and
- A reduction in testing costs.

Potential advantages will not come easily because there are many cultural hurdles to overcome. The limitation of competition (or apparent limitation) may need to be addressed with the contracting community. PENNDOT may need to clearly evaluate the risk assignment to better determine costs. The determination of performance criteria will be an important factor in this risk determination. Finally, PENNDOT still has legislative issues that need to be addressed because it cannot use a short list for DB contracts.

The A + B + other factors options is well understood by all parties, is proven, and would result in less complex bidding and award procedures, as well as less complex specification language. This option still allows for warranties to be added and is a good vehicle for adding incentives for quality, safety, and traffic management. For this corridor, however, it may lead to a longer project delivery time (design followed sequentially by construction). It also may require

multiple contracts and more management and project testing by PENNDOT staff. This option is not nearly as good a vehicle for constructability and innovation input from the contractor. It also requires PENNDOT to coordinate traffic impacts with one or more contractors. For this option to work, PENNDOT needs to have the ROW clear, to take full responsibility for the utility adjustments, and to have a completed geotechnical investigation prepared.

Many team members believed that the DB option is better suited to this project. Construction could be completed within 2 years, quality could be managed better, comprehensive public information and involvement could be managed more efficiently, and the design and construction decisions could be much better integrated.

Travel and Mobility ITS Team

Even before beginning construction, this corridor already has a constrained traffic flow; there is very little area to work between the river and the embankment. In addition, there are few alternative routes.

Many members of the travel and mobility ITS team suggested that a thorough analysis and evaluation of existing traffic patterns before construction would be invaluable to better predict movements and requirements during construction. This could be accomplished through an origin–destination study, quick zone traffic simulation, and use of NETSIM/CORSIM to evaluate queue lengths.

Although the first impression is that four through lanes should be required during construction, members of the team suggested that PENNDOT consider three lanes. Three lanes would allow PENNDOT to

- Incorporate 12-ft lane widths to increase driver comfort and maintain 35 mph design speed, subject to a detailed evaluation so they can be effective as reversible lanes with overhead lane control;
- Incorporate raised/reflective pavement makings; and
- Incorporate a positive separation (barrier) on the west side between travel lanes and the work/staging area to maintain safety, thereby protecting both travelers and workers and providing construction access while improving traffic flow.

Eliminating bottlenecks is critical to traffic flow. This includes the 31st Street Bridge. Traffic flow could be maintained by closing the 31st Street Bridge and Rialto Street to PA-28 and eliminating an existing signal during construction. Access to the island could be maintained through River Road and the 31st Street Bridge (from city side). Additionally, on the 40th Street Bridge, PENNDOT should consider eliminating the signal at the intersection, making the northbound a right turn on bridge continuously, a left turn off bridge prohibitive, and a right turn only off bridge.

ITS technology includes many possibilities that can be included on this project. They include a project-based TMC, a project website, a highway advisory radio, wizard CB radio, vehicle detection for speed and presence, queue detection, camera surveillance, a 511 demonstration project, an IM system, technology-assisted police enforcement, kiosks and video monitors, and changeable or variable message signs. All of these concepts should be explored further.

For a project-based TMC, PENNDOT could use wireless technology to communicate

with the permanent TMC based in Bridgeville via a link to existing PENNDOT fiber optic. The wireless technology eliminates the barrier of the lack of a permanent infrastructure for this corridor. A permanent ITS infrastructure could be installed as the project progresses. It could be placed in the utility corridor. The advantage to this strategy is linkage between the corridor-specific traffic management and the regional TMC. The technology could include a project-based TMC, a project website, highway advisory radio, camera surveillance, kiosks and video monitors, and VMSs.

For an IM system, it is possible to use wireless technology and solar power to provide camera surveillance of traffic flow during construction. The team also suggested that tow trucks and service patrols be dedicated to the project. Finally, surveillance cameras could be linked to the project website, thereby providing real-time information to the traveling public.

For the public involvement and education campaign, the following options were suggested:

- Conduct an intensive public involvement campaign, similar to that undertaken for the Ft. Pitt Bridge closure;
- Communicate the changes in traffic patterns before construction (bridge closures, movement restrictions, and so forth);
- Use kiosks and media;
- Use ITS equipment to communicate changes in real time through the construction zone;
- Promote travel demand management (e.g., car pooling, telecommuting, ride sharing, flexible work hours);
- Investigate Park and Ride—possibly undertake a joint venture with the Port Authority of Allegheny County (innovative contracting) and the Heinz plant and its employees; and
- Inform the public through an extensive involvement and education campaign, including pre-trip information, real-time information, and the promotion of travel demand management such as carpooling, telecommuting, ride sharing, and park and ride.[1]

Utilities will have a major effect on traffic management. The travel and mobility team listed an advanced utility relocation contract as an option. If technically feasible, the team suggested relocating utilities to a dedicated corridor. It also suggested the geotechnical option of constructing as much of the southbound roadway and retaining walls as possible in the first construction season. This step could be a triple boon to the project—improved geotechnical quality, higher construction speed, and less impact on traffic.

Although much time is spent on the traffic services required, the "who provides traffic services" issue is equally important to the eventual success of the project. The travel and mobility team listed the following options:

- Have the construction contractor be responsible for furnishing, operating, and maintaining a project-based TMC;
- Provide a separate contract for traffic monitoring of all ITS elements;
- Develop performance and selection requirements that could be turned into incentives for traffic management during construction;
- Have the lead design firm be available during construction for traffic monitoring; and
- Have the construction manager be responsible for the TMC services.

The team also suggested that a DB option be considered and explored in more detail. This option would allow for the development of project-specific selection criteria. The selection criteria could be related to the DB team's projected time of completion, its traffic management plan and demonstrated history of traffic management, and its demonstrated history of successful public relations campaigns and incident response plans. From this information, PENNDOT could develop performance and selection requirements that could be turned into incentives for traffic management during construction. For this to be effective, the DB team would need to evaluate the existing traffic patterns suggested previously. It also would need to determine current and potential travel times through the corridor and make allowances for closing signals at the 31st and 40th Street Bridges.

Constructability Team

One of the biggest challenges to the constructability of the project is getting equipment in and out of the site while minimizing the impact on the traveling public.

The constructability team offered the following suggestions:

- Perform constructability reviews throughout the design process. The constructability group would consist of a volunteer contractor group, retired DOT staff, or a consultant with expertise in this area. The project schedule could be reviewed for constructability issues during design as well.
- Establish a stakeholder advisory group to include representatives from the railroads, the city of Pittsburgh, the Heinz Company, utility companies, local community representatives, and any affected residents or business groups. Because its facility is adjacent to this project, the railroad must be a key player in this group.
- Conduct a subsurface utility evaluation as early as possible in the process. The scope of this work would include identifying all utilities related to the railroad operations as well. Consider a utility tunnel or corridor along the side of the road. This may be the most cost-effective strategy for handling future utility work. Locating all utilities in one corridor facilitates future access for maintenance operations while at the same time minimizing traffic disruption. Include utility issues in the DOT construction contract. This should allow improved coordination between the prime construction contractor and the affected utilities. However, the DOT still needs to provide some oversight to ensure that critical milestones are met.
- Develop a schedule of construction process with the goal of keeping the major traffic disruption to 1 year. The essential operations would include preproject activities such as demolition and structure removal. In Year 1, relocate utilities and construct the embankment and structures. The intent is to begin work in all areas where disruption to the existing facility is minimal. In Year 2, construct the new pavement and structures.
- Explore innovative methods for transporting materials. Because of the existing traffic congestion along PA-28, the use of haul trucks for transporting materials to and from the project site should be minimized. The river provides a viable alternative transportation option via the use of barges. In addition, using railroad cars on the adjacent railroad line should be investigated. There is some experience internationally in using blimps and helicopters for special item movement.
- With the very narrow working area, try to establish sites for project staging before releasing the construction contract. Areas to be considered include the St. Nicholas Church

property, the Millvale Industrial Park, the Heinz property, or even barges. Additionally, it is important to identify waste and reuse options. To maximize waste excavation and to minimize haul costs and traffic disruption, reuse of excavated embankment material should receive a top priority for this project. Part of the design effort should include the evaluation innovative removal techniques. Limited blasting or mechanical removal methods are suitable for this project. Also, particularly for the wall excavation, a conveyor system could be used to transport material across the roadway to temporary storage areas or hauling operations adjacent to the river.

- The walls are critical to both construction and long-term success of the project. The designer should (*a*) consider long-term service of the retaining walls as part of the project design, (*b*) create an aesthetically pleasing wall, and (*c*) support top-down wall construction.
- Consider use of nighttime construction to expedite the schedule and to enhance material handling operations. Night operations may need to be included in negotiations with the local authorities. If there will be restrictions on the type of operations allowed, they need to be clearly included in the plans and incorporated into the overall project schedule.
- Given the complexity and accelerated delivery schedule, use DB. The traditional process using a single contract for design and a single contract for construction of the project would probably not meet the desired schedule. Incentive and disincentive strategies could be used. Finally, A + B bidding would be an appropriate choice for this project.

The constructability team recognized the importance of the geotechnology to the success of the project. Team members suggested that the geotechnical team identify possible issues with slope stability, noise, air and water quality, traffic disruption, protection of adjacent structures, erosion, and sediment control.

Long-Life Pavements Team

Many members of the long-life pavement team believed that a 60-year design life was feasible for this project and that major intrusion on this corridor in later years would have a dramatic impact on the movement of traffic. Many also noted that either an asphalt or concrete option could meet the design life requirements. Overall, members of the team believed that the utility issue and the future need to gain access to service them through the pavement must be evaluated as the prime impediments to ensuring a long-term pavement.

If PENNDOT elects an asphalt pavement option, the members suggested

- A polymer-modified binder in the two upper layers;
- A stiff, nonmodified binder for all other layers; and
- Stabilized subgrade if the modulus of rupture is less than 7500 psi, which is highly likely.

For a PCC option, the members suggested

- Plain-jointed PCC,
- 15-ft joint spacing,
- Noncorrosive dowels,

- Tied shoulders, and
- Stabilized base.

Many members of the long-life pavement team also suggested that PENNDOT build a composite pavement option that integrates the best of the asphalt and concrete options. The top course could consist of a curable, rut-resistant asphalt surface, with saw and seal asphalt concrete joints to provide a smooth and quiet ride. The PCC could be the same as the PCC option previously mentioned.

Regardless of the type of pavement section, many members of the team suggested inclusion of the following construction requirements:

- Specify a strong select borrow material for the top 12 in. of subgrade,
- Apply a prime coat sealer on the subgrade, and
- Place the drainage system at the edge of the cut slope.

Many members of the long-life pavement team supported a DB contracting option, allowing the designer–builder to select the pavement system. They suggested the following performance requirements:

- Design and build the pavement for a 60-year design life.
- Use the NCHRP 1-37A Design Guide, when available, or an acceptable mechanistic design approach.[2]
- Design a system that would not require rehabilitation for the first 20 years. The rehabilitation could be done at night, and all lanes could be left open during daytime hours.
- Use a 10-year performance warranty for construction, with due consideration given to asphalt and concrete solutions. The performance factors could be developed for IRI, friction, noise, cracking, rutting, faulting, and surface distress.
- Set the performance levels on PMS information for high-quality good pavements.

Modular and Prefabricated Bridge Systems Team

The bridge team recognized that the area available for construction and staging is constrained. It also recognized that PENNDOT and the contracting industry are largely unfamiliar with the use of prefabricated systems.

Members of the bridge team noted several areas in which prefabrication could be used and made the following suggestions:

- Allow the use of prefabricated structural units to expedite construction at the 31st and 40th Street Bridges. If the bridge is on the critical path, the contractor would have the option to use the technology.
- Build drilled shaft (bent) structures to limit the scope of retaining walls.
- Relocate and elevate single-lane ramps at 31st Street to reduce the need for retaining walls, assuming this technique is cost-effective.
- Consider new material technologies to build longer-lasting structures (e.g., steel with improved corrosion resistance and high-performance concrete).

FIGURE 8 Texas DOT precast, prestressed bridge construction.

Members of the bridge team also recognized that utilities are a significant issue and, many team members believed that, to the maximum extent possible, utilities should not be placed under the roadway. If there is no alternative to placing utilities under the roadway, construction of a three-sided precast concrete culvert, 20-ft wide × 12-ft high (as dictated by the utilities team), should be considered. The culvert could serve three roles: utility tunnel, retaining wall, and elevated roadway.

ROW Team

The ROW team noted the significance of the railroad ownership of property parallel to existing roadway. The team also noted the challenges in relocating residential, business, and nonprofit structures that exist near the current roadway. A not-so-minor problem is the presence of billboard and other advertising signs along the route.

Many members of the ROW team suggested the development of a flexible (pre-ROD) hardship acquisition program using federal-aid funds with the concurrence of the FHWA division. Also, as necessary, PENNDOT should pursue early (pre-ROD) acquisitions that are 100% state funded with credit to state matching share, assuming that there are available state funds. Many members of the ROW team also suggested the development of a strategy to address the acquisition and removal of approximately 50 outdoor advertising devices within the project. Potential litigation by the sign owners may delay the project development and clearance of necessary ROW.

Although not applicable to this project, PENNDOT may wish to seek FHWA approval of a pilot project to use incentives to settle before filing condemnation, similar to the pilot being conducted in Florida. Team members also suggested flexible use of hardship acquisitions—PENNDOT may wish to request that FHWA delegate some approval authority, with the criteria set out in advance.

The ROW team, like most other teams, suggested close coordination with utilities and design. Many team members believed that the three disciplines should coordinate activities to inventory the existing utilities in the project area and to identify and evaluate potential relocation

corridor(s). This should be done as soon as possible. They also suggested that the design and utilities teams work with the ROW team to determine whether more than 30 partial acquisitions should be considered for full ROW acquisitions. A joint field inspection by a joint team from ROW, design, and utilities within 90 days would be appropriate.

Worker Health and Safety Team

Two important issues to consider as the corridor is designed and constructed are limiting worker exposure to public traffic and construction vehicles and equipment and addressing potential worker fatigue during an accelerated construction process.

Members of the safety team offered the following suggestions for consideration:

- A site-specific safety plan should be required as a bid item, and worker safety should be integrated with public safety planning. At each juncture of project scheduling, safety practices should be woven into the project. The contractor could assign a single entity that could have the overall responsibility and accountability for safety on the project. The safety issue should be a key element of the pre-bid meetings with the contractor community.
- Construction vehicle traffic on the site should be controlled by requiring the contractor to provide off-site worker parking and busing and by establishing alternative systems for the delivery of materials. The contractor should include this in the safety plan.
- The safety plan should address the incorporation of safety practices into the project scheduling. PENNDOT should take the lead on this issue during the design and require the contractor to do it as part of the overall safety plan.
- Although there are no scientific standards concerning worker fatigue, the contractor should closely monitor and manage worker stress, assuming many long hours and days throughout the project life. The contractor should be required to establish and administer a substance abuse screening and control program. Both could be considered in the safety plan. However, to equalize the bidding process, the DOT may want to establish some time restrictions in the contract specifically for workforce rest periods. Also, PENNDOT should examine the legal issues related to mandatory substance abuse screening and control.
- A contracting clause could be added that provides safety performance incentives. Although there is no experience with this concept, team members recommend that it be studied nationally. As of now, the contractor has some incentive through the insurance carrier to maintain a high safety record.

Utilities Team

Members of the utilities team clearly understood the utility challenges associated with this project and the potential for delays and cost overruns. They also noted the limited availability of space to relocate the utilities. Of utmost importance is the identification and location of existing utilities.

With this in mind, they suggested the following options:

- Engage construction contractor expertise early in project design;
- Use the best SUE technologies early in design and provide the construction team with the ability to use SUE;

- Include all utility work in the project scope, assuming that agreement can be reached with the utility companies;
- Relocate utilities before road construction;
- Eliminate the need for certain utilities with loop modifications, if possible; and
- Vacate the existing building and eliminate the need for local services.

The first choice for relocation of the utilities is to move them outside the roadway. Utility relocation can be performed under a separate Phase 1 contract. The possibility of financing the utilities relocation should be explored. The second choice for relocation is to build a utility access tunnel near or under the side of the road.

PENNDOT WORKSHOP CLOSURE

Senior PENNDOT representatives accepted many of the suggestions and ideas for consideration as the project evolves. PENNDOT will probably not use DB because certain restrictions in Pennsylvania allow only a modified approach. However, PENNDOT will include as many innovative contracting methods as possible, primarily incentives.

ENDNOTES

1. This is a regional issue. PENNDOT will work with the SPC and the Pittsburgh Downtown Partnership, at a minimum.
2. If PENNDOT includes a long-term warranty, it should consider whether it is proper to require a specific design procedure as well.

CHAPTER 5

Summary of Workshop Output and Closure

This process of examining accelerated construction has been an extremely illuminating and challenging process. Representatives involved in all three workshops were assembled to summarize what was learned. Following are their significant observations:

MANAGEMENT

Over the next decade, the need to apply accelerated construction strategies will grow both in numbers and in complexity of projects. An interpretation of the available statistics supports this conclusion, as do customer expectations. There is no single solution to the multidisciplinary, multitiered issue of accelerated construction. The existing roles and responsibilities of many of the key organizations are changing, but probably not as fast as will be required over the next decade. These organizations should consider a central source of information and coordination.

TECHNOLOGY TRANSFER

Excellent strategies and tactics are being used on many projects; however, sharing of this information within the state and across the country needs major attention. A methodology that allows the identification and sharing of innovative strategies among the various DOTs and industry should be developed. This should include interactive list-serve functions. Again, a central point of information and coordination would be extremely beneficial.

CORRIDOR ANALYSIS

Accelerated construction assessments that start before the final establishment of project and budget limits provide more flexibility to managers. Corridor studies can be effective tools for identifying the key issues and for ensuring interdisciplinary cooperation. Setting goals for a corridor or project appears to be a positive way to focus on the key issues. The establishment of clear and realistic goals helps the engineers to craft solutions or to report on options. Corridor approaches and the subset “mix of fixes” are emerging strategies that can integrate work needs with traffic impacts. They are not widely understood or applied at this stage. To support this concept, continued development of the “corridor” and “mix of fixes” concepts should be considered. The ACTT workshop concept, if applied, could help to further define the corridor approach.

SECONDARY DISCIPLINES

It is apparent that smaller specialty disciplines—utilities, ROW, and geotechnology, for example—are often critical to ensuring that corridors and projects advance steadily and do not delay construction once it is under way. However, some evidence indicates that this is not normally the case. Both the Indiana and Pennsylvania workshops identified these secondary disciplines as the most critical to advancing the corridors. These secondary disciplines, in turn, should explain the value of their getting involved early. Primers should be developed that focus on acceleration aids and that explain options that should be considered by project managers and executives.

CONSTRUCTABILITY

There is a growing need for one or more constructability reviews during the corridor or project development phase. Constructability reviews can be accomplished without prejudicing the bidding process, as many DOTs can attribute. A constructability review done before the establishment of project limits or project budgets for all major projects could be very beneficial.

INNOVATIVE (NONTRADITIONAL) FINANCING

Many new financing tools have come on line in the last several years. These can help to bring corridors and projects to reality earlier. However, the financing plan must be linked to the innovative contracting and warranty strategies and to the construction schedule. If innovative financing is being contemplated, it should be analyzed in conjunction with innovative contracting, bridge and pavement warranties, and maintenance personnel, which are all interconnected.

ROLES AND RESPONSIBILITIES

Current and future reduction in both the numbers and experience of employees within the DOTs may require major transfer of responsibilities to the construction and design industries. However, there is little effort under way nationally to identify (*a*) the specific services that could be transferred, (*b*) the work that is uniquely governmental and must be retained, (*c*) the risks associated with the transfer, and (*d*) the ability of the receiving organization to provide the services.

UTILITIES AND RAILROADS

Utilities are thought of as being the leading cause of construction claims. The issue is exacerbated in an incentive-based project. It is a difficult and challenging issue. Likewise, railroad relocation is difficult to coordinate, especially with the major consolidation that has been under way over the last decade. The regional nature of both utilities and railroads makes the

DOT's coordination effort much more difficult. A national strategic forum with AASHTO, FHWA, the construction industry, national railroads, and key utility companies convened to understand the issues faced by all the organizations and to develop a common agenda of what might need to happen to resolve and improve relations might be very beneficial.

ACCELERATED PROJECT PARTNERING

Although long-duration accelerated projects may start well with partnering, the longer they last, the more difficult it is to maintain teamwork and cooperation. Additionally, many mid- to small-sized construction companies do not have the trained personnel to staff accelerated construction projects. The toughest work goes to the best employees. These projects often demand long hours and nights, pose higher job risks, and involve overall high stress. A toolbox of techniques should be developed for (*a*) helping to detect early signs of breakdown in cooperation, (*b*) recommending ways to improve cooperation and alleviate stress, and (*c*) suggesting ways to rotate employees or require time off from the project.

INCENTIVES

Incentives have produced exceptional results in meeting both time and quality requirements. However, most agree that time demand pressures challenge quality requirements. A project with a $25,000 per day time incentive, for example, may include only a $2,500 per day incentive for quality pavement smoothness, for example. Several new initiatives should be considered. The first initiative is to complete work on defining an overall "Q" factor to go with A + B time factors that will elevate attention to final product quality. The second initiative would be to examine softer project goals such as safety, traffic management and traffic flow, utility location and relocation, engineering quality, partnering, for example, and developing an overall project management quality index and incentive.

SPECIFICATION LANGUAGE AND RAPID TESTING

The low-bid, method-specification process may restrict the innovative, performance-related effort that many are seeking in accelerated construction work. Interest in innovative contracting strategies—DB, warranties, best value, for example—are generally growing but not without controversy. PRSs are many times mentioned as having the potential to improve innovation. However, PRSs are frequently interpreted differently within the industry as to what effect they might have on innovation. For example, PRSs do not, by themselves, eliminate prescriptive language. More definition and education is needed in this field. Research that develops performance specification language that could be used in lieu of the common method language would be a good foundation document. End result principles, as well as warranties, should be examined as well. New innovative tests that focus on testing those attributes that really identify product performance will be required as well.

VALUE ENGINEERING

Value engineering before construction should be restructured to become a more effective tool that creates additional innovation as it relates to accelerating construction. As part of this consideration, the conventional 50–50 split between the contractor and the agency for approved submittals might be increased as an incentive to propose other time-savings initiatives.

PROJECT CONSOLIDATION

There is a trend toward consolidating the number of construction contracts both to handle traffic and to accommodate the DOT workforce. This trend also leads to an increased dollar value of the projects and puts exceptional pressure on the small- to mid-sized construction firms. It is important to recognize that the contract consolidation, along with innovative contracting strategies, are in response to the need to (*a*) accelerate projects, (*b*) improve quality, and (*c*) alleviate DOT personnel shortfalls. None of these pressures will decrease in the future, which in turn requires a fuller understanding of risk transfer from one organization to another.

STATISTICS AND THE CUSTOMERS

No single source of key statistics can help identify the extent of the change needed in the future or track the extent of acceleration under way. Statistics that could be packaged include lane closure policies, incentive-based project usage, safety in work zones, construction workforce accidents, innovative contracting mechanisms, and so forth. Construction activity and congestion are linked in the minds of the public. Better statistics could be used as an advantage in promoting additional patience as part of the planning process. The public appears to be willing to accept high-intensity, short-duration closures for construction work. This could lead to more high-intensity, short-duration shutdowns of roadways to do as much work as possible in a shorter period of time. This also may help to build longer-lasting, higher-quality facilities.

PREFABRICATION AND MODULAR TECHNOLOGIES

Prefabrication and modular technologies can considerably speed construction, and they need to be advanced. In the future, these technologies could be included as allowable alternatives to cast-in-place technology not only to meet time constraints but also to meet warranty or quality considerations. Pavement technology should be included in this technology group as well.

WORK ZONES IMPROVEMENT AND ITS USAGE IN CONSTRUCTION

Work zones improvement technologies are both merging and emerging. However, both the construction industry and the inspection workforce need to better understand the use and application of work zone improvement on construction projects. Initiatives aimed directly at the construction industry that examine ITS technology and describe its applicability would be

extremely beneficial. It is important that ITS be presented as an integrated system, not just a collection of individual products. The initiatives also should include guideline procurement language, bid strategies, QC checks, and so forth.

NATIONAL RESEARCH

Rapid renewal is a relatively new concept being defined under the Future Strategic Highway Research Program Study. Many of the items mentioned in this report should feed directly into identifying the long-range research needs of that program.

ACTT WORKSHOPS AND NATIONAL RESOURCES

The two workshops in Indiana and Pennsylvania showed great results and, if applied elsewhere, could prove to be a solid way to communicate the many details associated with accelerated construction. Appendices C and D provide the details. The ACTT workshop process will, as a spin-off, identify a pool of national experts who could be available to DOTs for future assistance.

TECHNOLOGY TRANSFER

One of the most difficult technology transfer efforts is identifying and sharing the many good work efforts that happen on individual projects. It is difficult to (*a*) identify them, (*b*) document them, and (*c*) share them. A creative new approach to technology transfer in this area could be extremely beneficial.

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APPENDIX A

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APPENDIX B

Guidelines on Organizing and Managing an Accelerated Construction Technology Team Workshop

After the Indiana and Pennsylvania workshops, FHWA and the AASHTO Technology Implementation Group (www.aashtotig.org/) agreed to organize an implementation program to promote the concept of accelerated construction technology transfer. At their request, the following guidelines were developed on how to select the right corridor and how to conduct an ACTT workshop.

STEP 1: ORGANIZE THE NATIONAL TEAM

1. Identify the national ACTT management team.
2. Identify the ACTT project manager.

STEP 2: SELECT THE CORRIDOR

Ask the following questions:

1. Is this corridor (project) a candidate for major reconstruction or rehabilitation within the next 4 to 6 years? The corridor needs to be on the DOT's real agenda.
2. Is the project an artificial or long-range project?
3. Is there an urgent need to accelerate construction? Consider both the DOT and customer viewpoint before deciding.
4. Is the planning process before or during the environmental stage?
5. Are the project limits or boundaries still fluid?
6. Is there general openness to innovation and a willingness to consider and apply new concepts?

If the corridor (project) substantially meets the these requirements, it is probably a good candidate.

STEP 3: ORGANIZE THE DOT ACTT TEAM

1. The host DOT should establish a management team and a single point of contact as the ACTT project manager.
2. The team should have representatives from the key organizations within the DOT.

STEP 4: SET CORRIDOR GOALS AND SCOPE

1. Identify the overall corridor goals, objectives, urgency, needs, and so forth. One of the most critical elements of workshop success is the establishment of the goals (performance goals) for the corridor. These should be clear, bold, and attainable.
2. Determine the specific customers—public, abutters, and so forth—and their expectations.
3. Describe how this corridor (project) would be built under "normal" circumstances.
4. Determine the potential impact on the traveling public, business development, work, and so forth under normal circumstances. This means the normal lane shutdowns, delays, and so forth for the years the project would be under construction.
5. Develop preliminary corridor goals for the workshop. These goals will be revisited later. The goals will be very broad at this stage—challenges to the teams. Goals should address the following:

- Year to begin or end construction,
- Years to construct (3 years as opposed to 6),
- Reduced consultant contracts,
- Reduced construction contracts,
- Consistent traffic flow (45 mph minimum versus 3 lanes open at all times), and
- No adverse effects on major events.

6. Determine the critical skill sets needed to design and build the project. Consider ROW, utilities, pavements, bridges, safety, mobility, financing, contracting, health and safety, geotechnology, work zones, and so forth The project scope will help define the specific critical skills needed.
7. Conduct the first meeting with senior DOT management. For the project to be successful, it is imperative that top managers be fully engaged. They ultimately are the project champions. Without them, it will be difficult to get buy in from the DOT technical staff. Top managers need to commit the department and approve the funding for the initiative.

STEP 5: ASSEMBLE THE NATIONAL AND STATE TEAMS—THE SKILL SETS

1. Finalize the key skill sets needed.
2. Develop a balanced team of national and state experts. Start with two to three national experts per skill set. In some skill sets, the technology may be very detailed, and it may be necessary to expand the list. Attempt to get the "best of the best" from the national pool. The national team should include at least 50% of those who have had previous experience with earlier workshops. Also, start with two to three state experts, including the private sector as appropriate. Team members need to know their roles and responsibilities. In addition to their expertise, they must understand the importance of teamwork.
3. Establish the overall message for each skill set. What is their expertise and their experience? Each skill set needs to have a script—an assortment of ideas of best practice, experiences, and the like—that can be shared with the new team.
4. Share corridor (project) documents among the team members.

5. Review the total number of team members and determine whether the number is manageable. With eight to ten skill sets and two to three experts per set, the national and state teams could range from 32 to 60 members. Including speakers, facilitators, managers, and so forth, the number could increase by 10 to 15 people. Check the venue details at this stage. Remember that the goal is to strike a balance between the needs and the ability to have interaction with the DOT team. Numbers count.
6. Determine the final role that local industry will play in the workshop. More than likely, this corridor is important to the private sector (e.g., consultants, contractors, suppliers). Most DOTs have "hot button" items that may be fundamental to the acceleration of the corridor. Prudence should be exercised in the invitation process. It may be worth scheduling a separate meeting with DOT management and the industry to explain the process.

STEP 6: CONDUCT PREWORKSHOP MEETINGS

1. Ensure that the ACTT management team visits the DOT, meets with key personnel, establishes the steering committee, and meets with senior management.
2. Present the overall purpose and mission of ACTT. The ACTT management team must make this as nonthreatening as possible.
3. Ensure that key DOT staff members are involved, including both management and technical staff. At this stage, one DOT staff member must have the lead responsibility to work with the ACTT management team.
4. Identify the workshop logistics, venue, facilitator services, and so forth. Some important concepts are as follows:
    - Schedule only one room per skill set. The rooms should be nearby to facilitate working together.
    - Establish a help desk that provides general information to all teams.
    - Schedule a corridor site visit. During this meeting, a corridor site visit is extremely important. A major concern during the workshop will be the need for and the time to conduct a site visit.
    - Develop the agenda, including opening speakers.
    - Identify the facilitator(s) and the report writer.
    - Keep the workshop short. It is generally suggested that the workshop be no longer than 1½ days.
5. Prepare workshop documents.

STEP 7: CONDUCT THE ACTT WORKSHOP

1. The workshop should include no more than 1½ days of business.
2. This may be the first time these teams meet. The steering committee should conduct an icebreaker, give out the packets, and explain the process.

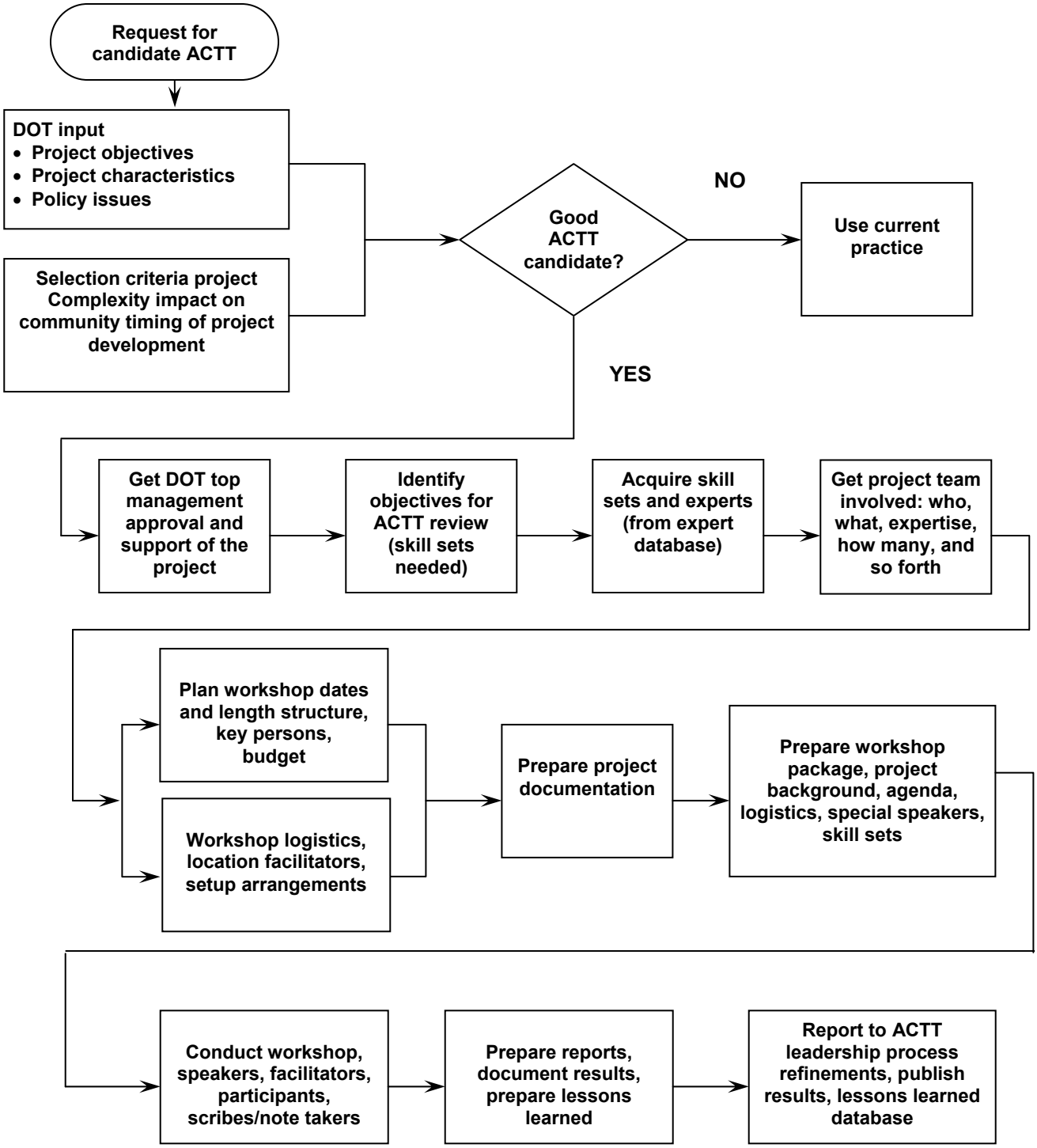
3. Day 1 Program
    - Plenary session:
        - General presentations,
        - Self introductions,
        - DOT senior manager charge,
        - ACTT national charge,
        - Project explanation,
        - Question and answer period, and
        - Breakout rules (e.g., scribes).
    - Skill team breakouts: Each team moves to separate rooms to discuss specific details associated with its technical area. National team members should present innovative or emerging methodologies. DOT members should present general practice and experience with the technology.
    - Skill team interaction: Teams must be encouraged to work together. The workshop points out the need to integrate different skills.
    - Team dinner: This is a good time to discuss "loose ends," the results of the day, and so forth.
4. Day 2 Program
    - Skill team breakouts and final presentation development.
    - Team assembly with skill team reports: The key to the presentations is a blend of (*a*) skill details and (*b*) key interactions with other skills.
    - Open discussion.
    - Workshop closeout.
    - Steering committee closeout meeting.

STEP 8: FOLLOW-UP AND REPORT

1. The first draft should be prepared within 30 days. This must be coordinated with skill set team members.
2. The ACTT team (facilitator and report writer) should return to the DOT to present the overall findings within 30 to 60 days.
3. At this point, the DOT needs to present its overall conclusions as well.
4. Prepare final report within 60 days, including a PowerPoint presentation.
5. Prepare 6-month and 1-year "quick reports" on the status of the recommendations.

APPENDIX C

Flowchart on ACTT Critical Elements



APPENDIX D

Acronyms and Abbreviations

A + B	cost + time
A5T60	TRB's Task Force on Accelerating Innovation in the Highway Industry
ACTT	Accelerated Construction Technology Team
DB	design–build
DBB	design–bid–build
DBI	Design–Build Institute
DOT	department of transportation
EA	environmental assessments
EIS	environmental impact statement
FDOT	Florida Department of Transportation
FONSI	finding of no significant impact
GARVEEs	grant anticipation revenue vehicles
IDOT	Illinois Department of Transportation
IM	incident management
INDOT	Indiana Department of Transportation
IRI	international roughness index
ITS	intelligent transportation system
MDOT	Michigan Department of Transportation
MSE	mechanically stabilized earth
NHS	National Highway System
NJDOT	New Jersey Department of Transportation
NMSH&TD	New Mexico State Highway and Transportation Department
NQI	National Quality Initiative Survey
PCC	portland cement concrete
PCMS	portable changeable message signs
PENNDOT	Pennsylvania Department of Transportation
PMS	pavement management system
PRS	performance-related specifications
QA	quality assurance
QC	quality control
ROD	record of decision
ROW	right-of-way
SPC	Southwestern Pennsylvania Commission
SUE	subsurface utility exploration
TDM	transportation demand management
TEA-21	Transportation Equity Act for the 21st Century
TMA	transportation management association
TMC	traffic management center
UDOT	Utah Department of Transportation
VMS	variable message sign
vpd	vehicles per day

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