U. S. Department of Transportation
Federal Highway Administration

National Institute of Standards and Technology

FINAL REPORT

Innovation in Vertical and Horizontal Construction: Lessons for the Transportation Industry

Submitted to:

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July 2005
Publication No. FHWA-IF-05-025

CERF
Advancing the Design and Construction Industry through Innovation

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FOREWORD

Innovation is the key that will make or break the U.S. highway industry, as it attempts to meet the anticipated demands and challenges inherent in providing a functional, efficient, and safe surface transportation system both in the short and long term. With an aging infrastructure, increasing traffic demand, and higher level of expectation by the traveling public, those of us involved in the delivery, management, and operation of our surface transportation infrastructure must rely more and more on innovations in technology, whether they are hard-side innovations (e.g., new rapid construction bridge systems or improved pavement mixes) or soft-side innovations (e.g., improved project management and finance approaches).

However, innovations by and of themselves, will not solve our transportation problems. Innovations must be adapted and adopted in order to suit the needs of a wide spectrum of transportation project personnel and institutional situations. The development, adaptation, and adoption of innovative approaches and technologies is in itself a complex process, and one worthy of study and assessment to see if the process can be made more efficient and effective. That, in essence, was the intent of the study conducted by the Civil Engineering Research Foundation (CERF) on behalf of the Federal Highway Administration's (FHWA) Office of Infrastructure, that is documented in this report.

With it's strong ties to the vertical (low and high-rise building) construction industries, CERF was able to open the doors and help FHWA examine how innovation occurs within the vertical construction industry. In addition, we were able to gather some very important and interesting innovative approaches which the vertical construction world uses to finance, manage, and deliver construction projects. Some of these ideas may be difficult to implement in public-sector construction; others may have direct applicability today. All of the ideas discussed in this report, however, have had a positive impact on the vertical construction world and are worth additional discussion and possible adoption as we try to innovate for the future in our delivery of a national surface transportation program to better serve the mobility needs of the nation.

King W. Gee
Associate Administrator for Infrastructure
Federal Highway Administration

PREFACE

The backdrop for the exchange of ideas which led to this study and report was the Corporate Advisory Board of CERF/ASCE where the pursuit of innovation in the design, construction, and maintenance industry is central to our mission. At the time, Dr. Charles Thornton, of Thornton-Tomasetti, was chairman of the Board and a key participant in the discussion leading to the concept of exchange between the vertical and horizontal construction sectors. The discussion started with the notion that the processes by which the vertical industry identifies and embraces innovation were likely quite different from the equivalent processes in the road and bridge industry, and that we should compare and contrast them to look for cross-over potential.

There was a certain presumption in this discussion that the most salient ideas with potential for transference would be found in processes for selection of construction means, methods, and materials. Our quest commenced with this premise.

In each of the city visits, when the discussions became focused in order to distill the lessons from the exchange, we found the dominant themes were construction delivery method choices and related procurement method choices; and capacity and skill of the project management team, including the owner component. Means, methods, and materials issues were consistently ranked second or below. In reflecting on this as a group the conclusion was that the team members saw higher return on investment in improving the choices for procurement and delivery methods (negotiated, best value, design-build, etc.) and in improving project management.

The last word (in this preface, at least) should go to Charles DeBenedittis, Senior Vice President with Tishman-Speyer, Inc., New York, and emeritus leader of the vertical industry owner/developer community. At the New York City meeting he was asked how the vertical industry team encourages innovation. His response was: “It’s all in the way we get to the price for the construction – we put everyone on the team early in the design phase when change is least expensive, and we ask for all the ideas and solutions to be put on the table; we make sure the team understands our objectives for the project, and we keep talking and deciding…..talking and deciding…..until we all understand what is in the final scope and what is in the price.”

Civil Engineering Research Foundation

EXECUTIVE SUMMARY

It is a common perception in the highway construction industry that new ideas and technologies are rather slow to be adopted and widely used. Meanwhile, skyscrapers get taller, and buildings significantly larger and more complex – leading to the appearance that the vertical construction industry innovates and adopts new practices much more rapidly in order to achieve these major advances.

In order to look at the methods used by the vertical construction industry to innovate and adopt new ideas, the Federal Highway Administration (FHWA) initiated a domestic technology scan focused on vertical construction practices. The scan project was modeled after the very successful international technology scanning program jointly sponsored by the American Association of State Highway and Transportation Officials (AASHTO) and the FHWA. The project was facilitated by the Civil Engineering Research Foundation (CERF) through a series of meetings, visits, and discussions with leaders of the vertical construction world. The objective of this Vertical Construction Scan project was to identify and understand the methods by which innovative technologies, processes, and methods come about and are implemented in the vertical construction arena.

A Steering Committee comprised of senior professionals thoroughly familiar with the horizontal and vertical construction industries and with experience in both the public and private sectors provided direction and guidance to the project. A Scan Team, representing AASHTO, State transportation agencies, the National Association of County Engineers (NACE), industry, and FHWA was assembled. Four members of the Scan Team were selected for their involvement in AASHTO technical committees (Design, Bridges, Construction, and the Technology Implementation Group). The Team was supported by a representative of the Prestressed/Precast Concrete Institute and the CEO of a leading building structural design firm.

CERF planned, organized and conducted three two-day scan trips to New York City (July 8-9, 2004), Chicago (August 5-6, 2004), and Los Angeles (September 22-23, 2004). The Scan Team met and had in-depth discussions with key executives, decision-makers, and managers associated with a number of internationally-known vertical construction companies and organizations, and was given access to a number of unique, cutting-edge projects and facilities.

The discussions clearly showed that there is a major distinction between the vertical construction industry and the horizontal construction industry, which is to a great extent related to the public sector-private sector divide. The key factors that affect the ability of the vertical construction industry and the horizontal construction industry to introduce innovation are the motivations and the regulations that drive and govern these two worlds, and they are fundamentally different.

The drivers for introducing innovative technologies, materials, systems and processes in the vertical construction industry are largely related to the profit motive. The vertical construction industry also has the flexibility typically inherent to the private sector, and is not subjected to regulations regarding contracting and procurement as is commonly found in public sector construction. In addition, the vertical construction industry is not averse to risk taking, which may lead to significant rewards (profits).

In the primarily public horizontal construction industry, the typical motivation of the owner is to be a good custodian of the public funds. Because public funds are being spent, the prevailing legal framework requires the decomposition of the project delivery process into three phases – design, bid, and build – and contract award to the lowest bidder. Risk is typically avoided by both owners and contractors, and there is often an absence of visible rewards.

A number of findings of the Scan Team relate to this fundamental difference. However, it was found that the great majority of recent innovations that have been adopted in the vertical construction arena have also been used, in limited instances, in the design and construction of highways. In other words, the perception that the horizontal construction industry is not moving fast and resists change is not justified when it comes to technological innovation.

The Scan Team identified 15 innovative ideas or concepts that the vertical construction industry has successfully implemented, and that have potential for application in horizontal construction. Three are in the area of information technology, one concerns aesthetics, and another deals with marketing and communications. The remaining ten innovative ideas that have potential benefits for the design and construction of highways are not about individual technologies but about the project delivery process including contracting, procurement, and associated issues.

The 15 innovative ideas identified by the Scan Team are summarized below.

Use of 3-D Modeling – 3-D modeling software can be used to more accurately model and detail construction projects. A 3-D model defines and communicates the architect's design vision to the various stakeholders and is a unique digital document that can be used for all phases of design, procurement, construction, and operation. A major benefit of using 3-D digital representations of projects is the ability to communicate graphical project information to all. A 3-D model can be used for design, analysis, and fabrication, and can help detect conflicts, interferences, and incompatibilities at an early stage, achieve improved tolerances and quality, and reduce change orders and rework. They serve all stakeholders involved throughout the life of a project and facilitate cooperation among them.

Use of 4-D Models – The 4-D computer modeling process integrates 3-D modeling with time. The 4-D software generates a sequence of configurations of the project representing its status through time, as determined from the schedule and the 3-D model, thus creating an animation of the construction process. 4-D modeling allows communicating actual construction sequences and can help detect constructability problems, interferences among trades or subcontractors, and interference between moving equipment and on-going activities. Anticipating and addressing such problems contributes to safety on the construction site, and enhances coordination among subcontractors and between the owner's operations and construction.

Web-based Project Management Systems – Web-based project management systems use project collaboration software to provide access for all parties (design consultants, contractors, subcontractors, managers, and others) on a large construction project to a secure, project-specific website or collaboration space in order to conduct all daily project management and administrative activities. The main benefits of such systems are increased productivity, reduced cycle time, and elimination of multiple iterations of the work process for project management, RFI processing, and invoice submittal, processing, and payment operations by allowing the members of a geographically distributed group to interact as if they were co-located. The use of web-based communications provides immediate access to accurate and complete project status.

Aesthetics – Aesthetic enhancement of projects increases their attractiveness and desirability, can serve to establish the identity of a district or city, and represent a statement of its spirit. Furthermore, much of the aesthetics features of most projects can be enjoyed by the general public, and aesthetics thus contributes to the quality of life.

Marketing and Communications – The success of many projects depends on funding and public support, which in turn often depends on how communication with the public, elected officials, decision makers, and the media is handled. Successful communication techniques stress the need for establishing and maintaining credibility, communicating the value of the project, ensuring that media coverage is more help than hindrance, avoiding mission expansion, and building a sense of pride and ownership.

Early Contractor Involvement – A contractor brought on the project team early in the process can assist in suggesting and evaluating design, finish, and construction process alternatives, and in reviewing the design for constructability and completeness. The project also benefits from the contractor's knowledge of current and projected market and pricing conditions, including labor, material, and equipment availability.

Innovation, Risk, and Reward – For the risk of introducing an innovation to be taken, it is necessary that a potential reward, of sufficient value, exist.

Process Flexibility and Opportunity for Innovation – For innovation to be considered, it is necessary that the contracting and procurement rules provide sufficient flexibility.

Ownership of Process – Roles and Responsibilities – With alternative project delivery systems such as Design/Build and Construction Manager at Risk, project teams are typically formed early in the process to work together to meet project goals. All the members of the project team have the opportunity throughout the life of the project to provide input, suggest improvements, introduce innovations, and contribute to the solution of unanticipated problems. Each team member has a stake in the successful completion of the project. These factors lead to the creation of a sense of commitment to, and pride in the project, of accomplishment, and of ownership of the process.

Project Management and Project Delivery Systems – Project delivery systems such as Design/Build and Construction Manager at Risk typically use the concept of a project management team in charge of a project from beginning to end, which enhances cooperation among the project team members and tends to foster innovation, cost effective solutions, and speedy project delivery. This provides better management continuity and knowledge of the project, including decisions and commitments. Such teams often use the most advanced project management techniques and risk management concepts to benefit the project.

Removing Barriers to Innovation – Barriers to innovation are numerous. They include the distrust that may exist between the contractor and owner's representative, concerns for the safety of the public and for potential liability, the lengthy process of proving the safety of a proposed innovation, resistance to change, and the fear of taking risks. To foster innovation, a change is required in the prevailing attitude of risk avoidance.

Streamlining – Streamlining in the areas of construction-ready design documents, commissioning, and all-inclusive insurance policies may lead to substantial cost and schedule reductions, and quality enhancements.

Procurement Methods – Design/Build and other alternate project delivery systems can deliver compelling and substantial benefits.

Life-cycle Considerations – The durability and long-term viability of building projects is extremely important to owners. For widespread acceptance of life-cycle cost innovations, it is imperative to establish a sound economic rationale for decision-making, and to define and place realistic costs on indirect, but very real, costs such as user delays, traffic interruption, accidents on detours, and the like.

Insurance – Insurance coverage and loss control activities are planned and pre-selected elements of risk mitigation. "Wrap up" insurance or an owner-controlled insurance program may provide cost savings, and remove a potential barrier to collaboration, especially during the planning and design phases.

For each of these innovative and promising ideas to be widely adopted in highway construction, a champion must be identified to spearhead the formulation and monitor a pilot deployment designed to test the validity of the concept, and identify the institutional changes that may be required. One of the tasks of such a champion would be to identify among the State transportation agencies a partner willing to participate in the proposed pilot implementation.

A steering committee should be set up to coordinate and monitor the pilot implementations, gather data from them, summarize and disseminate the findings, and then make appropriate recommendations for widespread implementation.

ACKNOWLEDGEMENTS

The development of this report was facilitated by the Civil Engineering Research Foundation (CERF) under the sponsorship of the Federal Highway Administration (FHWA) Office of Infrastructure. The work was conducted under a funding agreement through the National Institute of Standards and Technology (NIST), Contract #50SBNB0C1018. Any opinions, findings, conclusions, or recommendations expressed in this report are those of CERF and do not necessarily reflect the views of the FHWA or NIST.

The Civil Engineering Research Foundation and its staff assigned to this project wish to thank the individuals and organizations that have made it possible for the three Scan trips and meetings to successfully take place. Their valuable contributions are gratefully acknowledged.

In New York City, Dr. Jeremy Isenberg, Ph.D., P.E., CEO of Weidlinger Associates, Inc., kindly provided the meeting space and actively contributed to the meeting's discussions. The help of his assistant, Ms. Helen Pelekanos, with the logistics of the meeting is very much appreciated. David Palmer, P.E. Principal of ARUP, led the Local Organizing Committee and assembled a roster of distinguished speakers. Ms. Nancy Hamilton (ARUP), Mr. John Reed (Bechtel Corp.), and Mr. Glen Hughes (New York Times Co.) assisted with the arrangements and conducted the field visits of the Jamaica Station, Air Train, JFK Airport Terminal 4, and New York Times Building mock-up visits.

In Chicago, Mr. William Baker, P.E., S.E. (Principal, SOM) kindly provided the meeting space, led the Local Organizing Committee, and assembled a roster of distinguished speakers. His colleague Mr. John Viise, S.E., P.E. (Structural Engineer) was extremely helpful in making arrangements for the meeting and for the field visit of Soldier Field and of the One South Dearborn building construction project. Mr. Joe Dolinar (Lohan Caprile Goettsch) guided the Soldier Field visit. Mr. Trey Maclin (SOM) provided effective support and assistance regarding the logistics of the meeting.

In Los Angeles, Mr. Ed McSpedon, P.E. (Vice-President, HNTB) led the Local Organizing Committee and assembled a roster of distinguished speakers. He was assisted by his colleague Mr.Tony Gonzales. Mr. Gerry Seelman (Vice-President, DMJM-Harris / AECOM) kindly provided the meeting space, and Ms. Maria Suarez (DMJM-Harris / AECOM) helped with the meeting logistics. Ms. Rebecca Woelke (Frank O. Gehry Partners) assisted with the arrangements for the site visit to the Frank Gehry Partners Studios and Ms. Lorraine Robles provided effective support and assistance regarding the logistics of the meeting. Jim Glymph (Frank O. Gehry Partners) conducted the visit to the Frank Gehry Partners Studios and arranged for meetings with and presentations by Mr. Malcolm Davies (Gehry Technologies) on their new software platform. Mr. Terry Dooley, (Morley Construction, retired) guided the field visit of the Los Angeles Cathedral, and Mr. Marc Kersey (Clark Construction) that of the Caltrans District 7 Headquarters.

CERF also wishes to thank the numerous speakers and participants who have contributed to meaningful and enlightening discussions:

Lunch speakers
Gil Garcetti, author of *Iron: Erecting the Walt Disney Concert*
Frank Lombardi, Port Authority New York and New Jersey
Henri Petroski, Duke University

Presenters
William Baker, SOM
Frankee Banerjee, former Chief, Los Angeles Department of Transportation
Tim Buresh, Los Angeles Unified School District
Joe Burns, Thornton-Tomasetti
Jim Connell, Los Angeles Unified School District
William Cook, URS
James Dall, New York Dormitory Authority

Joe Dolinar, Lohan Caprile Goettsch
Charles DeBenedittis, Tishman-Speyer
Kristine Fallon, Kristine Fallon Associates, Inc
Nancy Hamilton, ARUP
Owen Hata, Nabih Youssef & Associates
Alice Hoffman, Hoffman Management Consultants
Jeremy Isenberg, Weidlinger Assoc., Inc.
Tom Kerwin, SOM
Jim Lammie, Parsons Brinckerhoff
Jon Magnusson, Magnusson-Klemencic
Matt McDole, E-470 and ASCE Transportation & Development Institute
Ed McSpedon, HNTB
Bill Moody, The John Buck Company
John Padoven, Bentley Systems
Dave Palmer, ARUP
Robert Parkridge, Smith-Emery
David Scott, ARUP
Gerry Seelman, AECOM DMJM+Harris
Mark Simonides, Turner Construction
Harry Walder, Walsh Construction
Ross Wimer, SOM
John Zils, SOM

Other Participants
Kevin Barnett, Turner Construction
Peter Bernstein, Turner Construction
Ron Burg, Concrete Technology Laboratories, Inc.
Tom Dooley, Morley Construction (retired)
Steve Moler, FHWA Resource Center, San Francisco
Michael Pfeiffer, ICC
David Shier, Walsh Construction
Tom Schlafly, AISC
Tom Verdi, Charles Pankow Builders

Ms. Suzanne Peterson (ASCE Conferences Department) and Ms. Pamela R. Smith (CERF) handled the many details that are the key to the success of meetings.

Last but not least, the guidance of the project Steering Committee under the leadership of Dr. Charles Thornton, Ph.D., P.E. (Thornton-Tomasetti), the sound advice of Ian Friedland, P.E. Technical Director, Bridge & Structures R&D at the FHWA Office of Infrastructure R&D, and the hard work of all the members of the Scan Team kept the project focused and on track. Their invaluable contributions are gratefully acknowledged.

1. OBJECTIVES

The Federal Highway Administration (FHWA), as a facilitator of innovation for state and local transportation agencies, is interested in understanding the methods by which innovative technologies, processes, and methods come about and are implemented in the “vertical construction” arena, i.e. buildings and related similar facilities. FHWA hopes to identify from that understanding elements that could help achieve advances and enhanced performance throughout the process of planning, designing, bidding, contracting, constructing, and maintaining highway systems.

To that end, FHWA initiated a Vertical Construction Scan program, whereby organizations such as the American Association of State Highway and Transportation Officials (AASHTO), Transportation Research Board (TRB), State transportation agencies, and others as appropriate were engaged in a process of discovery facilitated by the Civil Engineering Research Foundation (CERF) through a series of meetings, visits, and discussions with leaders of the vertical construction world.

In that quest to understand why and how innovation happens in the vertical construction world, the key issues initially considered were:

- What drives innovation?
- How does innovation happen?
- How are all those involved informed and educated on new technologies or processes?
- How are barriers to innovation removed or overcome?

Additional relevant questions that were considered included:

- Is the adoption of innovation in vertical construction faster than in highway and bridge construction?
- What are the similarities and differences between vertical construction and horizontal construction with respect to moving new technology, materials, systems, and processes into practice?
- Are long term life-cycle costs as important in vertical construction as in highway and bridge construction?

This scanning project was based on the assumption that sectors can learn from other sectors. Organizing meetings with leading members of the vertical construction world created the opportunity for the FHWA-sponsored Scan Team to listen to presentations that distilled the accumulated experience and wisdom of their vertical construction colleagues, “pick their brains” and have a meaningful and substantive exchange with them, observe and analyze illustrative examples of the technological and process innovations the vertical construction world has achieved, and stimulate the thoughts of the Scan Team members and the discussion among them.

In the course of the meetings, discussions and visits that were part of this project, it was expected that a number of innovative technologies, materials, systems, and processes recently adopted in the vertical construction world would be encountered. An auxiliary objective was therefore the compilation of selected innovations, followed by the identification among them of those with a strong potential for transfer or adaptation to highway construction.

A final objective of this project was to outline a plan for experimentation with, or for direct implementation of, promising innovative ideas culled from these interactions with key vertical construction industry leaders, and to disseminate information about them to the broader highway community.

The format of a scan program is such that the discovery of promising ideas depends to a large extent on the group of companies, people, and projects featured in the scan trips, and also on the members of the scan team, their professional background and experience, and their areas of interest. The results of a scan program are therefore unpredictable, and can never be definitive or repeatable. These limitations notwithstanding, a scan program has the undeniable advantage of stimulating the free and mostly unplanned exchange of ideas among participants with a diverse background, away from the daily pressures, and without the restraints imposed by the competitive nature of the business or by the client-contractor relationship. On balance, a scan program can be a cost effective way of questioning and taking a fresh look at the way we operate, of exploring a topic, and ultimately of contributing to the enhancement or updating of the tools and practices of highway and bridge project construction.

The methodology adopted for this Scan project is presented in Chapter 2. The key findings resulting from it are summarized in Chapter 3. Chapter 4 provides conclusions and recommendations. Appendices A through D provide details of the scanning trips and an expanded discussion of promising ideas identified through the Scan program.

2. METHODOLOGY

2.1 Steering Committee

It was essential at the outset of the project to assemble a Steering Committee of senior professionals thoroughly familiar with the horizontal and / or vertical construction industries, with experience in the public and / or the private sectors, to provide direction and guidance to the project. In order to adequately represent most if not all the stakeholders, it was necessary to include in the Steering Committee representatives of FHWA, AASHTO, major engineering and design firms, and major construction firms. The Steering Committee shown in Table 1 was appointed to guide and advise CERF in the conduct of the project.

Table 1: Project Steering Committee

Name	Organization	Location	Representing
Charles Thornton (Chair)	Thornton-Tomasetti	Washington DC New York	Vertical – Private
Ian Friedland	FHWA	Washington DC	Horizontal-Public
Ed McSpedon	HNTB	Los Angeles	Mixed-Private
Jim Lammie	Parsons Brinckerhoff	New York	Horizontal-Private
David Palmer	Arup	New York	Mixed – Private
Jim McKenna	Turner Construction	New York	Vertical-Private
Jon Magnusson	Magnusson Klemencic	Seattle	Vertical-Private
Bill Baker	SOM	Chicago	Vertical-Private
Cameron Kergaye	AASHTO	Washington DC	Horizontal – Public
Amar Chaker (staff)	CERF	Washington DC	N/A
Mike Goode (staff)	CERF	Washington DC	N/A

2.2 Scan Team

The Scan Team members traveled to major metropolitan areas to meet with leading members of the vertical construction world. The purpose of these meetings was to provide the opportunity for the Scan Team to listen to presentations that distill the accumulated experience and wisdom of their vertical construction colleagues, to "pick their brains" and to have a meaningful and substantive exchange with them, to observe and analyze illustrative examples of the technological and process innovations the vertical construction world has achieved and to stimulate the thoughts of the Scan Team members and the discussion among them.

A balance between representatives of the major FHWA Offices on one hand, and the State Departments of Transportation and AASHTO on the other was necessary to represent the federal and state points of view. More specifically, four members of the Scan Team were selected for their involvement in AASHTO technical units (Design, Bridges, and Construction Committees, and Technology Implementation Group). Additionally, the participation of a representative from the National Association of County Engineers (NACE) was deemed necessary, as city and county engineers typically face similar problems but with different access to resources. It was also felt that the participation of industry would be beneficial to the project, and key industry organizations were invited to participate. The Prestressed/Precast Concrete Institute and Project Steering Committee member from Magnusson Klemencic participated in the three scanning trips and meetings; while representatives from the American Institute of Steel Construction and the National Steel Bridge Alliance participated in the Chicago meeting.

The list of members appointed to the Scan Team listed is shown below in Table 2. It is comprised of six members from FHWA, four from State Departments of Transportation, one from AASHTO, one from

NACE, one from an industry association, one from a leading building structural design firm, and two from CERF. The biographies of the key project participants appear in Appendix A.

Table 2: Scan Team

Name	Position	Organization
Don Arkle	Chief, Design Bureau	Alabama Department of Transportation
Jerry Blanding	Innovative Contracting Engineer	Federal Highway Administration
Gary L. Brown	Technology Coordinator	Federal Highway Administration
Steve DeWitt	Director, Construction	North Carolina Department of Transportation
John S. Dick	Structures Director	Precast / Prestressed Concrete Institute
Alan Forsberg	County Engineer	NACE
Ian M. Friedland	Bridge Technology Engineer	Federal Highway Administration
David Hohmann	Bridge Division Design Section Director	Texas Department of Transportation
Cameron Kergaye	Engineering Management Fellow	AASHTO (and Utah Department of Transportation)
Bob Kogler	Bridge Design & Construction R&D Team Leader	Federal Highway Administration
Jon Magnusson	Chairman and CEO	Magnusson Klemencic Associates
M.G. Patel	Chief Engineer	Pennsylvania Department of Transportation
Cheryl Allen Richter*****	Highways for LIFE Team	Federal Highway Administration
Dan Sanayi	Construction & System Preservation Engineer	Federal Highway Administration
Michael Goode	Vice-President and Director, Industry Programs	CERF
Amar Chaker	Director, Engineering Applications	CERF

*Charles Churilla participated in the New York City meeting on behalf of Ms. Cheryl Richter

2.3 Local Organizing Committees

CERF assembled Local Organizing Committees that provided assistance in organizing the meetings. These committees were able to identify the key players in vertical and/or horizontal construction in their regions and facilitate their participation in the meeting as presenters, discussants, moderators, or field trip guides. CERF approached senior executives of companies that are members of its Corporate Advisory Board, and was able to identify in each of the three metropolitan areas a number of them willing to provide assistance by being the Local Group Leader. In all three cities, the assistance provided was tremendous, and far more extensive than expected. Appendix B provides the list of Local Organizing Committees members.

2.4 Preparation for the trips and meetings

Prior to the scanning trips, CERF developed a questionnaire to identify the primary areas of interest of the Scan Team members. At the outset of the project, it was anticipated that advanced technologies and innovative materials would be a focus of interest. Instead, the questionnaire showed that technology innovations were secondary, and that the majority of the Scan Team members had concerns and interest in process areas such as procurement and contracting. The survey results allowed CERF and the Local Organizing Committees to adjust the agendas for the scanning trips and to select the participants in relation to the areas of interest thus identified.

The composition of the Scan Team and the results of the interest profile survey show that the Scan Team members have diverse backgrounds, experience, concerns and interests. To help focus the discussions, CERF developed a discussion framework document that defined the problem at hand and summarized the key ideas to be explored during the scan trips and associated discussions.

An initial meeting of the Scan Team was held by conference call on June 29, 2004, prior to the series of scanning trips. The purpose was to prepare the Scan Team, review the discussion framework document, and engage the team in defining amplifying questions for the scanning trips.

Since the Scan Team was a geographically distributed working group, CERF established and maintained a secure, web-based group collaboration area using “eRoom” software (Documentum, Inc.). The dedicated eRoom was a repository for project documents and a means of communication and coordination among the project team members.

The discussion framework document is provided in Appendix C.

2.5 Scan Trips Meetings

CERF planned, organized and conducted three two-day scan trips, one each to New York City (July 8-9, 2004), Chicago (August 5-6, 2004), and Los Angeles (September 22-23, 2004), as part of this project.

In New York City, David Palmer (Principal, Arup) assembled a cadre of top level professionals well aware of current issues and of major trends in construction in the area. They, together with Mr. Palmer and his senior staff, prepared and delivered presentations tailored to the concerns of the Scan Team and participated in discussions with the team. They also made arrangements for the field trip that included the Jamaica Station, Air Train, and Terminal 4 at JFK Airport. Dr. Jeremy Isenberg (President and CEO, Weidlinger Associates, Inc.) hosted the meeting in his firm’s offices.

In Chicago, William Baker (Partner, SOM) and members of SOM’s senior staff participated in the meeting, and enlisted the participation of key players in the design and construction industry in the area. John Viise (SOM) assisted in this and made arrangements for the field trip that included Soldier Field and the One South Street Building construction project.

In Los Angeles, Ed McSpedon (Vice-President, HNTB) and his associate, Tony Gonzales identified key players in the design and construction industry in the area, and invited them to participate in the meeting. Gerry Seelman (Vice-President AECOM DMJM+Harris) hosted the meeting at his firm’s offices. The field trip included a visit to Gehry Partners Studio, and technical tours of the Los Angeles Cathedral of the Angels, CalTrans District 7 Headquarters Building, and the Walt Disney Concert Hall.

At all three meetings, other senior personnel of companies that are members of the CERF Corporate Advisory Board participated in and contributed to the meetings, including Thornton Tomasetti, Gehry Partners, Disney Imagineering, Parsons Brinckerhoff, Bentley Systems, and Bechtel. Altogether, the Scan Team had the opportunity to meet and have in-depth discussions with an impressive list of high-level engineers, managers, and executives, and was given access to a number of unique, cutting-edge projects and facilities.

At each of the three meetings, a well known keynote speaker was invited to address the Scan Team on topics of interest: Frank Lombardi (New York City), Dr. Henry Petroski (Chicago), and Gil Garcetti (Los Angeles). Agendas indicating discussion topics and participants at each of the three meetings are given in Appendix D.

Wrap-up discussions were held by the Scan Team at the end of each meeting to review and agree on key points discussed, and to prepare for the next project activity**.** At the conclusion of the last scan trip, a general discussion was held to examine the process by which the draft final report would be prepared, establish a preliminary list of topics to be discussed in the report, and discuss a draft action plan for dissemination and implementation. The outline for this report was developed and writing assignments were given to all Scan Team members.

The Scan Team at Soldier Field (Chicago)

3. FINDINGS

As noted in Chapter 1, one of the initial objectives of the project was to examine the process of innovation and understand the way innovation occurs in the vertical construction world, and to identify features that may be transferred to horizontal construction in order to help achieve advances and enhanced performance in the design and construction of highway infrastructure.

In the course of the three Scan meetings, visits, and extensive discussions, the *process* of innovation was not formally addressed, but there were numerous opportunities to observe its features and aspects as they relate to vertical construction. A number of individual innovative approaches were discussed at length. The discussions clearly showed that the drivers for introducing innovative technologies, materials, systems and processes in the vertical construction industry are largely related to the profit motive. This typically translates into the need to generate the most revenue out of a site or the need to deliver projects faster, which in turn allows developers/owners to take advantage of market opportunities and to generate revenue earlier. This motivation has led the vertical construction industry to introduce, experiment with, and adopt new technologies, new materials, new forms of procurement and contracting, new flexibility, new patterns of distribution of tasks and responsibilities, new forms of collaboration, and new forms of incentives.

Time and again, this has been contrasted with the typical motivation of the owner in the highway construction industry which is to be a good custodian of the public funds, leading to the prevailing legal framework that requires the decomposition of the project delivery process into design, bid, and build phases, and the awarding of the contract to the lowest bidder. Two other characteristics of the public sector are the absence of visible rewards, and the risk aversion that stems from the liability associated using new materials, technologies, and approaches. In the vertical construction industry the means and methods are left to the contractor. In the horizontal construction industry, the contracts specifications are typically prescriptive.

Beyond this private sector-public sector divide, the Scan Team identified technologies, processes, and procedures the vertical construction industry has adopted to facilitate greater efficiency and productivity in designing and constructing buildings, and that are likely to have similar benefits for the horizontal construction industry. Some are technological innovations, others relate to the project delivery process, and still others are about the way people relate to projects.

The great majority of recent technological innovations that have been adopted in the vertical construction arena have also been used, when appropriate, in the design and construction of highways. Examples of such individual technological innovations include: high performance steel and concrete; high durability concrete; composites materials; concrete, admixtures, and form systems that allow removal of forms and progress of construction in greatly reduced time; a variety of energy dissipation devices that enable structures to resist extreme events; embedded sensors for real time concrete strength evaluation; scissor lifts; and GPS and laser technology for control of construction equipment. The most striking finding of the Scan may well be the fact that most of the innovative ideas with potential benefits for the design and construction of highways are not about individual technologies but about the project delivery process and associated issues.

The sections that follow present a synthesis of the Scan Team findings where each of the innovative ideas ("nuggets") identified is described, its benefits are outlined, and any implementation issues are noted.

3.1 Use of 3-D Models

3-D modeling software can be used to model accurately and in complete detail any construction project. A 3-D model is a tool that defines and communicates the architect's design vision to the various stakeholders. It centralizes the building process in a unique digital document that can be used for all phases of design, procurement, construction, and operation. Its many benefits include the following:

- Owners who often have difficulty visualizing a proposed design from 2-D blueprints can now view in 3-D all aspects of the design, request changes, and see those changes made.
- Engineers from various disciplines can provide their individual design components to the model, and potential conflict areas can be identified and resolved well before the project is under construction.
- Structural elements can be designed, analyzed, and detailed for fabrication directly and seamlessly from the 3-D model.
- 3-D modeling also facilitates constructability reviews, the objective of which is to identify problems before they are encountered on site.
- Errors during the construction phase due to the workers' inability to read (visualize) the plans are reduced, improving the likelihood that the final product will actually be what the architect and engineers designed.

One notable example of 3-D modeling is the structural frame of the new Soldier Field[1] in Chicago. Thornton-Tomasetti performed the main structural analysis for the stadium framing with SAP2000 (Computers and Structures, Inc.) for 3-D analysis. To accelerate the steel fabrication and erection process, Thornton-Tomasetti used Xsteel 3-D-modeling software (Tekla Corporation) to produce a full-size, annotated computerized model. Once the model was created, piece drawings for fabrication and general-arrangement drawings were produced automatically. Generating 3-D models for each of the stadium's four quadrants, Thornton-Tomasetti was able to prepare documentation for the steel beams, beam sizes, member forces and camber required for each beam and column. Steel fabricator Hirchfeld Steel Co. Inc. used these 3-D models to complete the connection detailing, prepare shop drawings, and operate the computer-controlled machines used to cut and punch the steel. As an added benefit, the 3-D geometry of the steel work was available to Permasteelisa Cladding Technologies, facilitating the design and assembly of the stadium's non-rectilinear panelized cladding system. Permasteelisa utilizes the 3-D modeling program CATIA in the design and production of its cladding systems.

As mentioned above, a major benefit of using 3-D digital representations of construction projects is the ability to communicate graphical project information to all. In addition to these visualization benefits, 3-D digital representations of construction projects can be used at all stages of the life of the project: preliminary design; detailed project design, including geometry definition, structural analysis, and quantity take-off; constructability review; estimating; bidding; construction; definition of detailed scope of work for specialty subcontractors; fabrication; documentation of change orders and as-built project; commissioning; operation and maintenance; retrofit and modifications; and demolition. Such 3-D digital representations of construction projects can help detect conflicts, interferences, and incompatibilities at an early stage, achieve improved tolerances and quality, and reduce change orders and rework. They serve all the stakeholders involved throughout the life of a project and facilitate cooperation among them. For that reason, the use of 3-D model representations for construction projects carries the promise of delivering the benefits of interoperability, including the elimination of multiple data entry phases and costly errors and incompatibilities they may introduce. Furthermore, such 3-D models have the ability to accurately represent complex geometries, and provide a library of reusable components and modules which could streamline the design of projects involving prefabrication.

Several implementation issues need to be addressed when one considers using 3-D modeling in the design and construction of highways. First, the state transportation agencies need the necessary software and hardware infrastructure for these models. It should be noted that platforms exist which allow full visualization and annotation of 3-D models without requiring that the full-fledged graphics application be present on the computer. Next, it is necessary that all state transportation agencies personnel involved in the review of the design, the bidding process, the construction, and the operations and maintenance of highway projects be trained on the use of these tools. The same goes for designers,

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[1] Joseph Burns, David McLean, "Field Goals", *Modern Steel Construction*, July 2004.

estimators, contractors, subcontractors, and all field personnel. Finally, the issue of ownership of the 3-D model needs to be clearly settled, the current trend being that ownership of the model rests with the project owner.

Cantilevered seating, Soldier Field Stadium

3.2 Use of 4-D Models

The 4-D computer modeling process integrates 3-D modeling with the fourth dimension – time – to improve communication, coordination, planning, and execution of construction projects. The 4-D software in effect generates a sequence of configurations of the project representing its status through time, as determined from the schedule and the 3-D model, thus creating an animation of the construction process. In the vertical construction industry, 4-D software is being used on both remodeling and new building projects.

An example cited during the meeting is the Project 4-D software[2] by Common Point Technologies used on several hospital rehabilitation projects in California and on the new Walt Disney Concert Hall. The advantage of this 4-D software is that it is compatible with most scheduling software. On the hospital projects, 4-D modeling helped the CM team explain proposed construction sequences and communicate several "what if" scenario alternatives to hospital administrators and staff, as well as to construction field

[2] Common Point, Inc., Project 4D™, http://www.commonpointinc.com/products/project4d.html

personnel. This assuaged one hospital administrator's fears that the renovation activities would completely disrupt her health care operations. The 4-D model showed where and when – by actual calendar date – each ward and individual rooms were scheduled for renovations to minimize disruptions to specific hospital operations. On the new Walt Disney Concert Hall project, 4-D modeling identified a potential conflict between steel erection and the future installation of a large HVAC unit.

The benefits of using such 4-D software are many. 4-D modeling allows communicating actual construction sequences. It helps in detecting problems due to the geometry. For example, if a piece of equipment is to be installed at a given time, the configuration of the partially constructed project at that time must be such that it is actually possible to bring the equipment in. More generally, 4-D software can help detect constructability problems, interferences among trades or subcontractors, and interference between moving equipment (e.g. cranes) and on-going activities. Anticipating and addressing such problems contributes to safety on the construction site, and enhances coordination among subcontractors and between the owner's operations and construction. 4-D software can show when different portions of a project, such as lanes in a highway project, or rooms or offices in a building project are in or out of service. It can therefore help detect situations where the construction sequence conflicts with desired operational characteristics. Furthermore, simulation of changed conditions (e.g. weather) is straightforward.

Currently, highway contractors on most construction contracts are using scheduling software to plan, track, and control the construction activities. These schedules could be easily integrated with a 3-D design to produce a 4-D model for highway projects. Some potential benefits of including the time element are: analyzing traffic control sequencing/detour impacts during peak traffic periods such as tourist seasons, special events, etc; determining weather impacts on specific construction activities; and identifying and tracking schedule impacts due to multiple subcontractors.

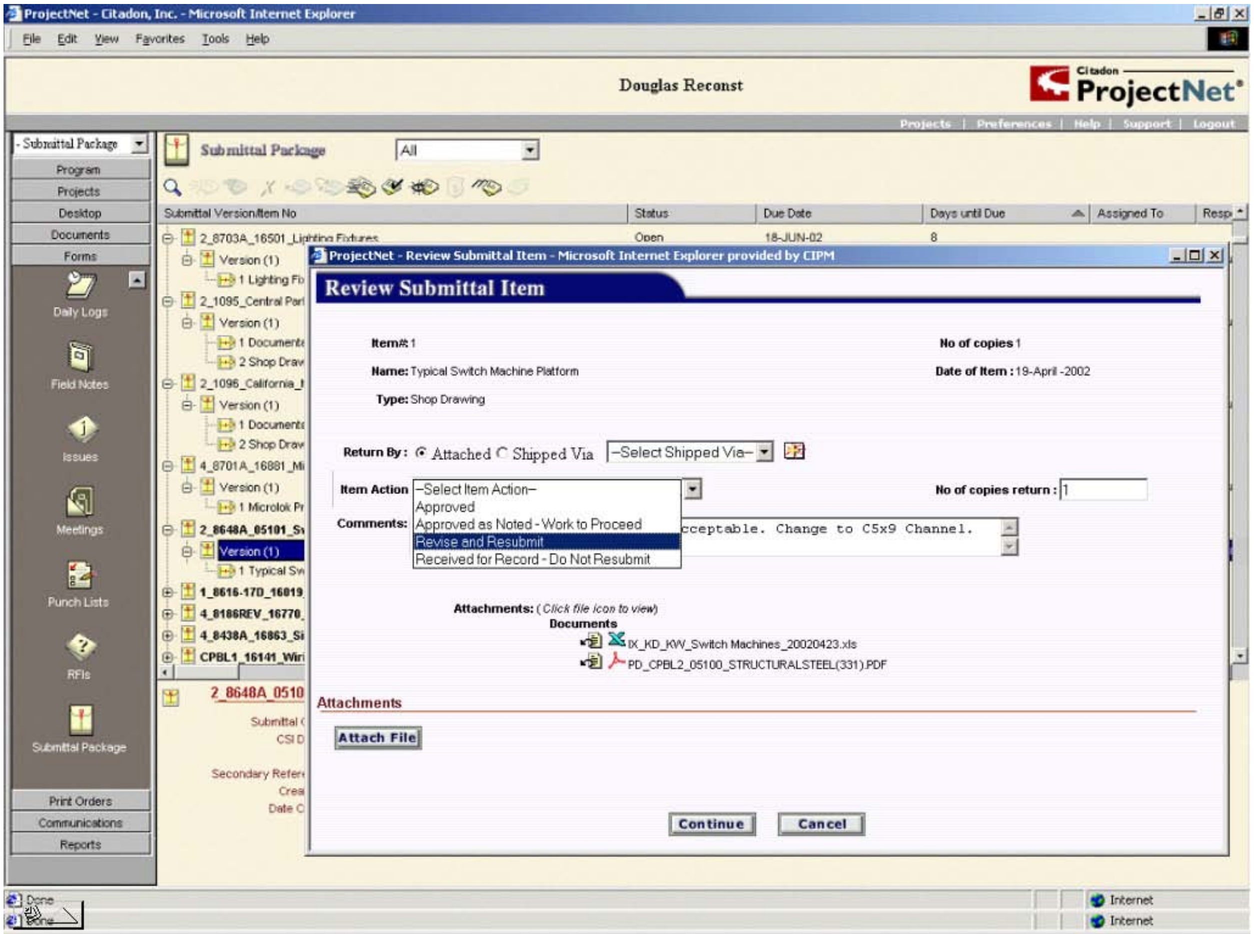
In order to expand the use of 4-D modeling in the horizontal construction industry, it is necessary for the industry to first embrace the use of 3-D design modeling.

3.3 Web-based Project Management Systems

Web-based project management (PM) systems use project collaboration software to provide access for all parties (design consultants, contractors, subcontractors, managers, et al.) on a large construction project to a secure, project-specific website or collaboration space in order to conduct all daily project management/administration activities. Requests for Information (RFI), material submittals, and other PM information can be directed to the applicable decision makers, and an audit trail of their decisions can be obtained. Invoices can be submitted, reviewed, and processed. Correspondence is exchanged and archived.

The Scan Team was briefed[3] on the use of a web-based project management system on the Chicago Transit Authority's (CTA) 5-year $2.1 billion Capital Improvement Program (CIP). The key software features needed to support the program goals were identified and the capabilities of one such system, the Citadon™ ProjectNet® Docs solution, were demonstrated. The Application Service Provider (ASP) approach minimized implementation time and contained costs. As an ASP, Citadon provides and runs the project management software on their servers, provides the data storage, manages server and software maintenance and upgrades, and handles data backup and disaster recovery. All users access the software and data via the Internet. The system provides "private" areas on the website for collaboration between general contractors and their subcontractors, as well as between design consultants and sub-consultants. The system provides benefits to all users. The system provides access, accountability, and an audit trail.

[3] Kristine K. Fallon, "Keys to Success in Web-based Project Management: The Technology Implementation Perspective", Presented at the APTA 2003 Rail Transit Conference.



Sample screen of a web-based project management software (Courtesy Kristine Fallon)

As a result, the CTA CIP is realizing quantifiable benefits of increased productivity and reduced cycle times. CTA senior technical personnel are processing two-and-a-half times as many RFI's per business day per person and responding 18% faster using the web-based system. In addition, the system contributed to the ISO 9001-2000 registration for the CTA quality management system for engineering and construction operations. The Illinois Road and Transportation Builders Association is encouraging other transportation agencies within the state to adopt the CTA system and approach.

The main benefits of such systems are increased productivity, reduced cycle time, and elimination of multiple iterations of the work process for project management, for RFI processing, and for invoice submittal, processing, and payment operations, by allowing the members of a geographically distributed group to interact as if they were co-located. The use of web-based communications provides immediate access to accurate and complete project status.

Similar web-based project management systems are being used on several highway mega-projects. Parsons, Brinckerhoff, Quade and Douglas, Inc. used ProjectSolve in the reconstruction and widening of 23 miles of Interstate 10 (Katy Freeway) in Houston, Texas. Turner Construction Company uses a customized version of the software Prolog – dubbed "Turner Talk" – in the construction of the Miami Intermodal Center at the Miami International Airport.

The costs associated with implementing and managing web-based project management systems on both vertical and horizontal construction projects currently limit their use to large multi-contract long term projects. An article in the October 11, 2004 issue of *Engineering News Record* concerning web-based collaboration software noted that adoption is still far from universal and is most applicable to high-value, long duration projects that stress collaboration. Also, it is probable that Internet service requirements and availability limitations currently preclude its use on rural projects.

The use of web-based project management systems will likely increase with the next generation of such systems that are being developed by several vendors. They are expected to be less costly to implement, to require less training, and to be suitable for medium-sized vertical and horizontal construction projects. Actual use will require access to reliable high-speed Internet service.

3.4 Early Contractor Involvement

As vertical construction is typically developer-driven and cost (as related to time to completion date and future profit potential, i.e., when the revenue stream can begin) is usually the most important element to the developer, building developers usually assemble and bring the full team together at an early stage in the project. This allows contractors and material suppliers to assist in suggesting and evaluating design, finish, and construction process alternatives, and in reviewing the design for constructability and completeness. This also allows the developer to benefit from the contractor's knowledge of current and projected market and pricing conditions, including labor, material, and equipment availability.

One of the reasons that this approach is effective in the vertical construction industry is that there are generally no restrictions on the pre-assembly of a project team, including identifying preferred and qualified short-list bidders for various services. Such early involvement is almost required in order to ensure a successful Design/Build approach to project contracting, as the owner and designer must be able to review and approve drawings for constructability and completeness much earlier than in the typical Design-Bid-Build process.

This approach provides many benefits: it takes advantage of the contractor's technical and market knowledge, which contributes to reduced cost and risk and enhanced project quality, and it removes most major reasons for future claims. A recent Construction Industry Institute study reported on at the meeting has shown the benefits of early collaboration.

The concept of early contractor involvement is "potentially adoptable" in the design and construction of highways. Some safeguards will be required in order to ensure that the bid process remains "clean", and that proprietary ideas and concepts can not be adopted by others as a result of open discussions regarding alternatives solutions. Such safeguards have already been demonstrated to work in practice both within the vertical construction industry and in some State highway projects.

3.5 Risk and Reward

Risk and reward can be very high in the vertical construction market. Very tall buildings and those that push the envelope of previous practice bring even greater risk and reward. Pressure is put on the schedule by the desire of the developer to start collecting rent, or by the developer's fear of market evaporation. Also, the developer typically desires to extract the maximum revenue from a piece of land. Sometimes, the desire to break records or to make an aesthetics statement – which bring their share of financial rewards – will be a driving factor. All these factors tend to lead to a high degree of innovation in vertical construction sector.

It is important to understand the relationship between innovation and risk and reward. In essence, all innovation carries risk. However, innovation also carries a chance of being very beneficial, in which case it is rewarded. In the vertical world, innovation can be the difference between success and failure, and the vertical industry appears to thrive on innovation.

Most vertical construction follows a Design/Build process. The owner/developer hires a team to design and build the project. The contractor enters the project without a completed design, accepts the project with many unknowns, and is therefore at risk. Budgets and time schedules are established, and the construction team must work and innovate in order to build the project on time and within budget. Saving time or money typically results in reward for the contractor.

This concept was a prominent theme on many of the vertical projects involving innovation. Examples included: innovative construction sequences (top-down erection of a steel frame in Boston, and up/up construction of the Westin Kuala Lumpur, which essentially involves starting the building's structure at two locations - at the bottom of the garage and at the ground floor level, once the excavation and foundation system are finished - and then progressing simultaneously upward); wind tunnel testing on a series of scale models that differed slightly from each other in order to minimize building forces on Burdj Dubai, the tallest building in the world; using the “phantom equity” concept (bonus based on the company's stock performance) to motivate and create a sense of ownership among the members of the design and construction team; and using innovative contracting such as negotiated guaranteed maximum price with a shared savings clause to align the interests of the owner with those of the contractor’

The degree of flexibility allowed by the contracting rules has a major influence on innovation. There are currently several contracting methods and provisions that allow innovation at the risk of the contractor. One such method, Design/Build, is currently being used in many state highway agencies.

Another approach that can facilitate innovation is construction value engineering (VE) which is currently allowed in most states. Value engineering allows the contractor to deviate from the plans and/or specifications in order to save cost. If the state approves the VE proposal, the cost savings is then split between the owner and the contractor. One of the shortcomings of the way construction value engineering proposals are currently handled is that it only allows the successful bidder to be innovative after the project is awarded. If all bidders were allowed to offer VE proposals at the time of the bid, all bidders would have a chance to propose innovation. Opening the construction VE process to include proposals at the time of the bid could provide more opportunities for innovation. Awarding the contract based on the lowest cost innovative response would provide the owner the maximum cost savings.

An alternative bid is similar to bidding VE proposals, but could also provide additional flexibility and innovation. Some, but not all, contracts have provisions for alternate bids such as asphalt versus concrete paving or steel versus concrete bridges. States could open the bidding process to accept bid proposals that not only suggest these types of alternatives, but also changes in the terms and conditions of the contract. Appropriate clauses must, however, be found to ensure that the alternate solution proposed is equivalent to the original project specification in terms of performance as measured in terms of quality, capacity, durability, and safety.

3.6 Process Flexibility and Opportunity for Innovation

As stated previously, vertical construction is mostly developer-driven and associated with profit motivation. The private sector procurement and contracting approaches offer a great deal of flexibility, which in turn provides many opportunities for innovation, streamlining, and alternate solutions, all of which can result in cost and time savings.

Design/Build is used extensively in the vertical world for these reasons. Other vertical construction approaches also can provide these same opportunities. The Guaranteed Maximum Price (GMP) concept is a good example of this. As Harry Walder (Walsh Construction) said at the Chicago Scan meeting, ‘Fixed fee, fixed insurance cost, fixed general conditions, short-listing process – There is no incentive for me to do anything but to be up-front and honest and make the job a total and complete success”. The GMP concept allows a contractor to be brought in early in the development of a project and have valuable input into the design. Constructability, value engineering, and process economies, all become part of the development process in a way that simply cannot be done in the Design-Bid-Build world.

A critical element that needs to be addressed to provide incentive for innovation is the need to have appropriate risk sharing mechanisms. Contingency pools where a shared savings of the contingency is available could help temper this risk. On high risk items (utility relocations for example) the work involved can be included in a contingency pool and, if the contractor can provide innovative approaches to utility relocation that expedite the process and yet save cost, the contractor could share in the savings of the contingency.

The vast majority of highway construction projects follow very traditional Design-Bid-Build processes. Inherent in this traditional system is a very rigid approach that often limits opportunity for contractor innovation. Currently, many highway agencies are experimenting with other contracting options that do allow for greater flexibility. These include the Design/Build procurement process, opportunities for bid alternates, and other alternative contracting mechanisms.

While there are significant differences between the private sector and governmental agencies in terms of how they operate, there are approaches to providing flexibility and opportunity for innovation that can be taken from the vertical construction industry and used, with minimal modification in certain circumstances, in the highway construction industry.

Many elements of Design/Build, for instance, can be integrated into traditional Design-Bid-Build to provide some of the same benefits. For instance, pre-bid conferences with individual contractors with confidential questions are being utilized in Design/Build, and are used extensively in the vertical construction world. Highway agencies need to find a way to allow contractors to ask questions about innovation to ensure that their ideas will be accepted, without fear that they will be given to all other contractors bidding on a particular project.

3.7 Ownership of Process – Roles and Responsibilities

With alternative project delivery systems frequently used in vertical construction such as Design/Build and Construction Manager at Risk, project teams are typically formed early in the process to work together to meet project goals. The contractor's input is provided throughout the design process. The designer's responsibility is to the contractor as well as the owner. Specialty contractors and material suppliers can be brought early into the process as well. Owner representatives starting with a project manager with "cradle to grave" responsibility have more accountability and motivation for ownership of the project. In the ideal situation, the entire team works together from design through construction to meet project goals.

Design/Build contractors take on responsibilities for interface management and for quality that owners or their consultants have in a traditional Design-Bid-Build system. The Design/Build contractor becomes the integrator of the project, including the design of all systems and all the phases of construction, and has the responsibility for a quality end product, along with the documentation of the entire process.

Under these circumstances, all the members of the project team have the opportunity throughout the life of the project to provide input, to suggest improvements, to introduce innovations, and to contribute to the solution of unanticipated problems. Each team member has a stake in the successful completion of the project. These factors lead to the creation of a sense of commitment to, and pride in, the project, accomplishment, and ownership of the process.

This is to be contrasted with the traditional Design-Bid-Build project delivery system, where the process is segmented in phases, with well-defined actors responsible for each phase. This is typically a hand-off system where each group specializes in its part of the process or phase, completes it, and hands off the project to the specialists for the next phase. While this system provides owners with the maximum control of their project and may limit risk, it isn't conducive to the development of a sense of ownership by the project participants.

The approach typically used in vertical construction provides numerous benefits, both to the project and to the project participants. The project (and therefore the owner) benefits from the knowledge, experience, expertise, ingenuity, and insight of all the project team members. Designers, contractors, specialty contractors, and owner's representatives all feel responsible for the success of the entire project, not just of one of its phases. Attitudes change, cooperation is increased, decisions are made faster, and adversarial relationships tend to vanish. Change orders, claims, and rework tend to diminish. These factors all contribute to gains in terms of cost, schedule, and quality.

During the meetings with the leaders from the vertical construction industry, numerous examples demonstrating successful outcomes of this approach were presented and discussed.

Widespread implementation of this approach is strongly related to the issue of project delivery system. When regulations allow alternate project delivery systems such as Design/Build, implementation of this approach can be straightforward.

Partial implementation is possible even with restrictive regulations. For example, instead of the hand-off arrangement typically used in horizontal construction, the owner can use an approach that is closer to the "cradle to grave" model. It starts with the assignment of a project manager who is responsible for the project through all of its phases. For larger projects, additional members can be added to the project manager's team. Specialists for different phases, such as design and construction, can be given larger roles to provide review and input throughout the life of the project. Also, integrated teams can be developed, mixing owner's staff and consultants. Project team members can also be assigned from different departments of the owner's organization. These steps can be taken to enhance ownership of the process without changing from a traditional Design-Bid-Build contracting approach. Many owners have already implemented such steps and/or alternative project delivery contracting systems.

3.8 Aesthetics

The vertical construction world invests considerable money and effort in addressing aesthetics, especially in the private sector. Generally, developers have found a significant economic value to aesthetics. Aesthetic enhancement of a structure results in higher revenue through rents or sale, and the marketplace has a determining influence on aesthetics. Sometimes aesthetics are meant to create a "monument" for a wealthy individual or business.

Over the years, aesthetics have focused on styles which change: classical designs, skyscrapers, and now the flowing Gehry designs. In recent years for large public projects, naming rights have been sold to generate additional revenue. The desire to sell naming rights provides incentive to add aesthetic values if this results in greater naming rights revenue. Artwork is often included in public buildings, sometimes as a percentage of project costs (set-asides for the "arts" required by some jurisdictions).

Vertical construction projects are typically implemented by a team of discipline specialists. The most successful projects include a team of financial, architectural, engineering, and operating and maintenance specialists. The architectural partner is responsible for aesthetics and provides the training and talent required for this objective.

The benefits of incorporating aesthetics in designs are many. Incorporating aesthetics in designs increases the attractiveness, the desirability, and the economic value of projects, and can serve to establish the identity of a district or city, and represent a statement of its spirit. Furthermore, much of the aesthetics features of most projects can be enjoyed by the general public, and aesthetics thus contributes to the quality of life.

The profit test to measure aesthetic improvement is lacking in public horizontal construction. However, since we are dealing with the same population in the horizontal world and the vertical world, it is likely that aesthetic enhancements to roads and bridges are valued by the taxpaying public, our investors and "owners." In some cases aesthetic enhancements may take the form of a monumental bridge or parkway. More often it is good design labeled as "context sensitive," "lies easily on the land," "streetscaping," or "landscaping" achieved through public involvement.

Incorporation of aesthetics in highway construction is practiced to some extent. In the public horizontal construction world the test is not profit but political and public acceptability. With the strong pressure to minimize taxes, if aesthetics spending is not valued by public, there will be objections, and this will soon be reflected back to public decisions, especially in the very visible and accountable local government world. For privately funded highway projects, developers will certainly consider whether aesthetic enhancements result in greater profits. For example, most toll roads are attractively landscaped and maintained to help attract paying users. Naturalizing right-of-way and medians – e.g., wildflowers – provides “aesthetics” and also minimizes maintenance/mowing needs.

Implementation of this concept in horizontal construction can become more widespread if ideas such as those listed below are considered:

- Recognize that aesthetic enhancements add value to horizontal projects and design accordingly.
- Identify appropriate “monument” and “gateway” projects and develop accordingly. Not every horizontal project should be a “monument” or “gateway,” just as every building is not an icon.
- Include architects, landscape architects and artists on horizontal project teams for significant projects. Their expertise should be included throughout the project development cycle, not just at the end.
- Organize design competitions.
- Seek opportunities to include aesthetics in environmental mitigation features. For example, wetlands can have natural, flowing shapes. Holding ponds can include landscaped paths where appropriate. Some historic preservation projects can include public access and education.
- Seek simple, “form-follows-function”, “lies-easily-on-the-land” solutions for all projects. This can add aesthetic value to small as well as large projects.
- Solicit public involvement in projects. Community-sensitive design needs to be attractive to the citizens, not only artists and experts. Ties to local interest and historic themes can be effective.
- Include art in projects and expand on the concept of applying some project funds to art. A recent engineering company advertisement refers to “Creating Bridges as Art.” In Minneapolis, each of the recently constructed Hiawatha Light Rail Line stations included dedicated funds for art. The result has been well received by the public.
- Consider privatizing some projects -- this will automatically include a marketplace test for aesthetics.

Rather than legislate aesthetics, which may work in some cases but could also result in wasted funds, inappropriate designs, and added-on decorative features that provide little real aesthetic value, there is a need to initiate studies to identify what works and why, and to share these ideas and encourage their use through example and incentive.

3.9 Marketing and Communications

The success of many projects depends on funding and public support, which in turn often depends on how communication with the public, the elected officials, the decision makers, and the media is handled.

The experiences and recommendations of the vertical construction industry with regard to communication and marketing tend to validate and reinforce the lessons learned from the greatest successes (and failures) in highway construction. Specifically, proactive communications with the public can be vitally important to the overall success of highly visible and/or controversial projects. The recommendations offered addressed the following broad themes:

- Establishing and maintaining credibility.
- Communicating the value of the project.
- Ensuring that media coverage is more help than hindrance.
- Avoiding mission expansion (scope creep).
- Building a sense of pride and ownership.

With regard to credibility, the need for truthfulness, particularly for project costs, was stressed. One speaker put it quite succinctly, stating that "sucker budgets" result in lost credibility. It was also recommended that agencies capitalize on the image of the engineer as trustworthy, credible, and honest.

With regard to communicating the value of the project, speakers stressed the benefits of using 3-D and 4-D models to capture the imagination of the public by helping them to visualize both the end product, and progress toward achieving it. Representatives of the Los Angeles Unified School District cited the importance of communicating the social cost of inaction to make the point that not going forward with a project or delays in going forward with a project will have consequences that are more intolerable than the costs of timely pursuit.

With regard to the media, it was noted that it is wise to avoid attracting too much media attention. When dealing with the media, speakers noted that it is essential to:

- Always control the message.
- Get your story across as accurately as possible.
- Know how to get out the proper message.
- Be open and forthright.
- Tell the truth.
- Use media to your advantage.
- Anticipate controversy.

Speakers cited the need to be aware of the potential for individuals and special interest groups to "hijack" a project to advance unrelated agendas, and to avoid scope or mission creep. To guard against this, they cited the need to be aware of the agendas of people and interest groups with whom you must interact, and the importance of learning to say no.

The importance of building a sense of pride and ownership among those involved in and affected by the project was cited by several speakers. To achieve this, speakers advocated being strong self-advocates as well as measures to recognize and give credit to the "unsung heroes" of construction projects. A photo documentary of steel workers constructing the Disney Concert Hall is perhaps the ultimate example of such an effort.[4]

Virtually all of the communication and marketing practices that were discussed are applicable to highway construction, and many are already used to one degree or another. Communications and marketing campaigns have been undertaken to build or maintain good will in affected communities and encourage transportation choices – such as the use of mass transportation or alternate routes – that will reduce congestion around the construction project. For example Indiana's Hyperfix project, which involved full closure of the I-65/I-70 interchange in the heart of Indianapolis, featured an extensive public relations campaign, including the project signature name and logo, a comprehensive web site, extensive community outreach, multiple media releases and events with media kits, and rest stop displays. Similarly, the high profile project to construct the new Woodrow Wilson Bridge in the Washington D.C. metropolitan area includes an extensive communication and community outreach program, including a project website (http://www.wilsonbridge.com/).

The ideas with the greatest potential for increased use are those pertaining to communicating the value of projects, and building a sense of pride and ownership. In these areas, there is merit in considering expanded use of 3-D and 4-D models, more extensive efforts to communicate the value of highway projects, and particularly the social cost of not pursuing them in a timely fashion, and greater efforts to honor the highway construction workforce. These practices could be especially useful to agencies engaged in highly visible projects where a significant faction of the affected community is opposed to the project. By helping the community visualize the end result of the project and understand that the social

[4] "Iron: Erecting the Walt Disney Concert Hall," by Gil Garcetti, Balcony Press, 2002.

cost of delaying or abandoning a project is unacceptable, the highway agency may gain support that will facilitate project completion.

Implementation of enhanced practices to communicate the value of highway projects could be pursued by working with the owners of a small number of high profile/high controversy highway projects – Maryland's proposed Inter-County Connector, for example – to demonstrate the practices.

Highway agencies could implement the idea of honoring the highway construction workforce through awards for quality and by having their public affairs office provide and promote appropriate stories – a day in the life of the construction worker, for example – to the media.

Walt Disney Concert Hall

3.10 Project Management and Project Delivery Systems

The use of Design/Build project delivery is predominant in the vertical industry, which truly promotes excellent team work for the designer and the contractor. In vertical construction the contracting mechanism for retaining the project manager varies. It can take the form of "project manager for a fee" or "construction manager at risk", and some large owners have their own project management team.

The project manager retained for a fee generally acts as the owner's representative and works closely with the Design/Build team throughout the project. He/she makes most of the technical decisions with the owner's consent and gives guidance and recommendations to the owner on financial issues. The owner generally makes all decisions related to the functionality and financial aspects of the project. The project manager prepares project requirements for the owner, negotiates or bids the Design/Build contract, and manages the contract throughout the life of the project.

The construction manager at risk (CMR) bids or negotiates a contract with the owner with a guaranteed maximum price. The CMR assumes all of the risks and potentially also reaps significant benefits (higher profits). The CMR either partially performs the work and subcontracts out the remainder, or fully subcontracts out all work and just manages that of subcontractors to deliver the project. Normally, the designer (architect) works directly for the owner but also works with the Construction Manager to come up with cost effective solutions. In some instances (Turnkey Projects) the designer works for the Construction Manager.

Due to the relatively short life span of vertical industry projects, the project management team rarely changes. This provides better management continuity and knowledge of the project, including decisions and commitments.

Striking examples of successful projects using such contractual arrangements were presented during the Chicago meeting, with teams using the most advanced project management techniques and risk management concepts.

Speakers indicated that such practice obviously lends itself to cost effective solutions and speedy project delivery. With the Design/Build project delivery system, project management is not only efficient but very effective since the designer and the constructor have an on-going dialogue at every step of the way. Managing the project from the conceptual stage through completion of construction by a Design/Build team customizes the solution to the constructor's construction practices, and provides opportunities to introduce innovations and to substantially reduce costs and project delivery time.

For horizontal construction, even though numerous state, local, and semi-private agencies (owners) are practicing a variety of project management and contracting concepts, the majority of them practice the "Design-Bid-Build" and "award to the lowest bidder" concepts. The project management teams in most instances are different for the design and construction phases of the project. During the design phase of the project, the design team prepares contract documents to ensure that most contractors can bid and construct the project. The design is based upon common construction practices, which can stifle innovation, except for the items within the designed details and concepts depicted in the contract documents (specifications, plans and other requirements).

During the last couple of decades several agencies have made significant strides to move towards "innovative contracting" concepts from alternate design by contractors to Design/Build, in order to provide cost effective projects and substantially reduce project delivery time.

The ability to implement the concept of a project management team in charge of a project from beginning to end clearly depends on the project delivery system used. Project management practices may be enhanced as a result of the implementation of practices such as:

- Maintain project management continuity throughout the project; i.e. from project requirements (scoping) through the completion and commissioning of the project.
- Use web-based project management tools
- Adopt either "Construction Manager at Risk" or "Construction Manager as General Contractor" as additional tools for project management and delivery.
- Minimize project documentation by requiring documentation of end decisions or end results rather than documentation of all means and methods or other non-productive details, in order to minimize project management efforts.
- Adopt the practice of risk-based project management and inspection, instead of managing and inspecting everything with the same thoroughness. Give all responsibility of quality control to contractors and manage/inspect products through quality assurance programs.

3.11 Removing Barriers to Innovation

In the vertical world, the reputation of delivering a good product on time is a key factor for selecting contractors. Contractors that have a bad performance reputation aren't invited to bid on the project. Innovative contractors are valued for the potential they bring to a project to save money and/or time and for their ability of being creative in bringing about other qualities such as aesthetics or function. Contractors work to develop a relationship of trust so that they will be invited to submit a proposal on the next project.

The majority of vertical projects are done on a Design/Build basis without the same type of detailed contract plans and specifications that are typical in highway construction. As a result, the practice of strict adherence to plans and specifications that dominates highway construction is not common in the vertical world. In many cases, the owner decides the maximum price and duration, and the designer/contractor work to satisfy the needs of the owner. Innovation that saves money and/or time or enhances quality is welcomed.

Because public funds are being spent in highway construction, projects are generally awarded based on lowest bid. The role of the State DOT in managing the contract is to hold the contractor to the plans and specifications and not let the contractor manipulate the contract to his advantage. The relationship can almost be classified as one of distrust. There is therefore little incentive for the State transportation agencies to allow innovation on the part of the contractor.

Because highway owners have a public safety responsibility, highways must be built to accepted standards in order to provide the associated level of safety. Deviation from the standard is perceived in some cases as lowering the safety of the facility, and there is always concern that any innovation that deviates from the accepted standards may have safety consequences. The engineer's personal and professional liability is at risk when something outside of the accepted standard is tried. The innovation must be proven to be safer or at least as safe in order to be accepted. The process of proving the safety of a product or technology that has never been tried before can be complicated and time consuming, and may therefore discourage innovation.

The typical fragmentation of the design process in the highway construction world is another barrier to innovation. Many individuals and agencies have a part in the overall project. They represent different areas of expertise or authority and responsibility, and are looking out primarily for their individual interests, and not the interests of the project as a whole.

There are many barriers to innovation within typical transportation agencies. Many of these barriers are related to concerns over risk. These barriers include:

- Fear of not following precedent, which could result in potential court action if something goes wrong.
- Approval of new ideas, products, or processes may be slow due to the bureaucratic nature of municipal, State and Federal organizations.
- Specifications are strict due to problems with past contractors.
- Fear of failure for safety reasons.
- Concern, as stewards of taxpayer's money, that taxpayers will be left "holding the bag" for contractor's failed innovation attempts.
- Organizational resistance due to cultural issues ("we have never done it that way before").
- Small contractors are less likely to be interested in large scale attempts to provide innovation – large contractors tend to be more open to warranties, alternative contracting approaches, etc – as risk can be shared over a wider range of projects.
- Contractors, in general, are very good at project specific innovation but seem resistant to process change. It may threaten the "old way of doing business that brought us our success."
- Leadership does not always provide a culture, particularly in government agencies, where innovation is rewarded and "smart" failures go unpunished.

One of the first things that may be required to overcome the institutional barriers to innovation is a change in organizational attitude. The prevailing attitude is one of risk avoidance. Avoiding or at least minimizing risk to the owner is the focus of the design engineer, and thus explains the detailed nature of contract plans and specifications. Contractors are also interested in risk avoidance. Many plan details, specifications and pay items are the result of contractor input, given to avoid risk.

One idea for overcoming barriers is to provide an incentive for innovation. Incentives and disincentives are already used on some highway construction contracts usually in the form of added pay for finishing early, or payment penalty for finishing late. Vertical construction contractors prefer incentives or shared savings over disincentives. Disincentives occur after the damage is done. The money doesn't solve any problem: it is just punitive. Value engineering is one method already employed that can provide shared saving as a result of contractor innovation. The Port Authority of New York and New Jersey used a risk pool for Terminal 4 at the John F. Kennedy Airport in order to cover unknowns and overruns, with the stipulation that anything unspent would be shared equally between the owner and the contractor. This provided a strong incentive to find ways to save money.

Structure of Terminal 4 at the John F. Kennedy Airport

3.12 Streamlining

As mentioned earlier, the vertical construction industry utilizes streamlining for a number of design and construction related activities. Streamlining design documents into construction documents to bypass shop drawings saves a number of hours and potential errors. For the purpose of commissioning, the vertical industry often uses the practice of bringing on board during the construction phase the professional who will perform the operations and maintenance activities after completion. This ensures efficient service and appropriate knowledge for the post-construction phase through the warranty period.

Streamlining techniques are also used for insurance coverage. One policy is written to cover everything in the project, thereby grouping all items into one insurer's policy.

Such streamlining often yields substantial cost and schedule reductions, and quality enhancements.

The highway construction industry is also continuously seeking better and more efficient methods of design and construction. The term streamlining itself has not always been used for documented advances, although there has been a strong push for efficient methods in accommodating environmental requirements. The number of streamlined activities in horizontal construction is large and growing, and this report may contribute towards more. The three streamlining ideas outlined above clearly have the potential of benefiting the horizontal construction world in the areas of construction-ready design documents, commissioning, and all-inclusive insurance policies.

3.13 Procurement

Time and profit guide the procurement process in vertical construction projects. There is an overriding concern that delays or market variability may affect the economics of a project before completion. Efficient construction is the mantra in the vertical world and applies to both the costs of construction and its duration. The procurement of architectural, design, and construction services are more varied and interrelated than for horizontal construction. However, the selection process is less constrained by laws because of the near absence of public or government involvement. The owner, who is generally not a government agency, has more freedom and discretion in forming agreements with the providers of architectural, design, and construction services.

As noted earlier, Design/Build or Construction Manager at Risk procurement is predominantly used in vertical construction. In some cases, the concept of a shared risk pool is used. Numerous benefits results from such a flexible approach:

- Existence of a motivation to introduce innovation.
- Existence of sufficient flexibility to implement alternative solutions and value engineering.
- Possibility of streamlining the design and construction process in areas such as construction-ready design documents and all-inclusive insurance.
- Creation of conditions that allow ownership of process.
- Improved communication among the members of the Design/Build team, including the possibility of early contractor involvement, which allows taking advantage of the contractor's knowledge and insight for constructability review and other project-related issues.
- Reduction of change orders, claims, and rework.
- Reduction (or even disappearance) of adversarial relationships among the Design/Build team members.
- Creation of the conditions for cost effective solutions and speedy project delivery, including fast-tracking (i.e. construction of a portion of the project before the design of subsequent portions is finalized).

In highway projects, the procurement of design and construction services is predominantly achieved via Design-Bid-Build and uses two distinct contracts. The procurement of design services uses a qualifications-based selection process. The owner, who is typically a government agency, determines the best design consultant based on qualifications. The price of the contract is then negotiated after selection. The procurement of construction services is overwhelmingly accomplished via the low bid method. Because most roadways are owned or operated by federal, state or local governments, their choice of procurement methodologies is dictated by law, which usually stipulates award of the contract to the lowest bidder.

The exception to this rule in some states is Design/Build projects, where the design and construction portions of a project are combined into one contract. This option is exercised primarily to speed the construction of the project or to place the risks on the contractor.

As noted in previous sections, the public horizontal construction world tends to be risk-averse, mainly because of concerns for public safety and for liability. Also, it seems that the premium put on timely or early completion of highway projects may not be as high as in the vertical construction world, since the corresponding benefits to the highway users do not appear in the balance sheet.

While a number of states have introduced ways to implement Design/Build and other alternate project delivery systems, the fraction of projects using such procurement methods is still small. In view of the compelling and substantial benefits the use of such procurement methods can accrue, it seems worthwhile to promote a wider implementation of these more flexible and more nimble procurement methods. One approach would be to document that the interests of the tax paying public are well served by these approaches, that the public gets a better value for its money, that no additional risk is taken on by the state transportation agency, and that the safety of the public is in no way compromised.

3.14 Life-cycle Considerations

The durability and long-term viability of building projects is extremely important to owners. In the vertical industry, initial costs are important but life-cycle costs are equally important, and life cycle considerations are built into the business model. The owner has discretion in spending additional money during construction if the decision pays for itself over the life of the building. Innovative materials and processes that increase value and potential rental income or reduce future operating costs (for example through increased energy efficiency) are constantly sought out, and their implementation is rapid. Value is easily quantified by comparing initial cost to cost of maintenance, operation, and possible/potential increased revenue for owner.

In horizontal construction projects life-cycle costs are often considered, especially on larger, high-visibility projects. Prescriptive construction specifications are standardized and intended to ensure long-term durability. Life-cycle costing involves a multi-disciplined approach where designers work with material experts, construction engineers and maintenance personnel. Most decisions with regard to life-cycle costs are made during planning and design. An important factor in life-cycle cost decision-making is the institutional knowledge of the designers and owners involved in horizontal projects.

In order to get more widespread acceptance of life-cycle cost innovations in highway construction, it will be imperative to establish a sound economic rationale for decision-making. The horizontal construction industry should be encouraged to consider proven innovations from other construction industries if there is a potential for reduced life-cycle costs and no risk to durability. There is significant potential for life-cycle cost improvements, especially in the area of defining and placing realistic costs on indirect, but very real costs such as user delays, traffic interruption, accidents on detours, and the like. Implementation could come from the establishment of guidelines and recommendations by leadership entities such as the FHWA and AASHTO.

3.15 Insurance Impacts

Vertical construction projects typically require a thorough risk management review and a frank assessment of options for risk mitigation on a continuing basis. Insurance coverage and loss control activity are planned and pre-selected elements of risk mitigation. Owners must take into consideration the potential for removing incentives to good loss control practices by removing the participating firms' responsibility for providing their own insurance. For some firms it is a hallmark of their own internal strategy to manage loss control well in order to obtain advantages in premium pricing. There are also as many risk management issues for off-site activity as for on-site, given the adoption of pre-manufacturing and modularizing techniques (especially for buildings), with just-in-time delivery; and many of these off-site activities present loss control challenges. These factors may be disincentives to adoption of an owner-controlled insurance program (OCIP) approach. Icon facilities, ranging from very high rise buildings to stadiums, to regional transportation terminals, to shopping centers, present special risk management challenges because of the need to address malevolent attack risks, in addition to the array of natural and technological hazards. All owners of such projects are looking for a clearer identification of the role of government in underwriting such risks.

In highway construction, design consultants and construction contractors provide their own insurance, although the extent of coverage is specified (as minimums) in the contracts by the procuring government agency. On large projects, or programs of projects, transportation agencies are drawing from experiences with ‘wrap up’ insurance, or OCIP which have been evolving for 30 years in special transportation projects or in non-transportation projects. The drivers for adoption of such programs are usually two: cost savings, and removal of a potential barrier to collaboration, especially during the planning and design phases. The types of coverage elected for these OCIP arrangements vary, but almost always comprise general liability, professional liability (commonly, ‘errors and omissions’) for the professional services firms, workers compensation for the construction companies and site services providers, builders risk for the construction companies.

All of the vertical construction industry lessons listed above apply to the highway and bridge owners, especially those with large or mega-projects, or high-profile bridge projects. There is no ‘one size fits all’ for OCIP or for risk management driving the configuration of insurance coverage. It is essential to perform risk management, and to continually assess the changing risk profile of major projects.

4. CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

The presentations, discussions, and visits that took place during the three Scan meetings in New York City, Chicago, and Los Angeles, together with the additional discussions among the Scan Team members have led to a number of observations that are summarized below.

There is a major distinction between the vertical construction industry and the horizontal construction industry, which is to a great extent related to the public sector-private sector divide. The key factors that affect the ability of the vertical construction industry and the horizontal construction industry to introduce innovation are the motivations and the regulations that typically drive and govern these two worlds, and they are fundamentally different.

The drivers for introducing innovative technologies, materials, systems and processes in the vertical construction industry are largely related to the profit motive. Also, the vertical construction industry has the flexibility inherent to the private sector, and is not subjected to special regulations regarding contracting and procurement, and risk taking may lead to significant rewards.

In the public horizontal construction industry, the typical motivation of the owner is to be a good custodian of the public funds. Heavy public and special interest group involvement in public projects, and multiple audits by state and federal agencies force the owners to be extra cautious and require high levels of documentation. Also, because public funds are being spent, the prevailing legal framework requires the decomposition of the project delivery process into design, bid, and build phases, and the awarding of the contract to the lowest bidder. Risk is avoided by both owners and contractors, and there is an absence of visible rewards.

A number of findings relate to this fundamental difference. Beyond this dichotomy, it was found that the great majority of recent technological innovations that have been adopted in the vertical construction arena have also been used, when appropriate, in the design and construction of highways. In other words, the perception that the horizontal construction industry is not moving fast and resists change is not justified when it comes to technological innovation.

The Scan Team identified 15 innovative ideas or concepts that the vertical construction industry has successfully implemented, and that have potential for application in highway construction. Three are in the area of information technology, one is about aesthetics, and another is about marketing and communications. The remaining ten innovative ideas that have potential benefits for the design and construction of highways are not about individual technologies but about the project delivery process, contracting, procurement, and associated issues. This may well be the most striking finding of the project.

The 15 innovative ideas identified by the Scan Team are summarized below, and were discussed earlier in the report.

- Use of 3-D models
- Use of 4-D models
- Web-based project management systems
- Aesthetics
- Marketing and communications
- Early contractor involvement
- Innovation, risk, and reward
- Process flexibility and opportunity for innovation
- Ownership of process – roles and responsibilities
- Project management and project delivery systems

- Removing barriers to innovation
- Streamlining
- Procurement
- Life-cycle considerations
- Insurance

4.2 Recommendations

The concepts summarized above could be very beneficial in highway construction. Clearly, the vertical construction industry appears to have found ways to deliver projects efficiently. While these ideas have been successfully implemented in the vertical construction industry only a few of them had been considered to some extent for application in the design and construction of highways.

For each of these innovative and promising ideas to be widely adopted in highway construction, a champion will must be identified to spearhead the formulation of and monitor a pilot deployment designed to test the validity of the concept, and to identify the institutional changes that may be required. One of the tasks of such a champion would be to identify among the state transportation agencies a partner willing to participate in the proposed pilot deployment.

A steering committee should also be set up to coordinate and monitor the collection of pilot deployments, gather and assess data from them, and to disseminate findings. Based on the findings, the steering committee would make appropriate recommendations for widespread implementation.

APPENDIX A – BIOGRAPHIES OF KEY PROJECT PARTICIPANTS

DON T. ARKLE graduated from Auburn University in 1977 with a Bachelors Degree in Civil Engineering. All of Don's 27 years in the engineering profession have been with the Alabama Department of Transportation (ALDOT) where he currently holds the position of Chief of the Design Bureau. Mr. Arkle is one of ALDOT's delegates to the AASHTO Subcommittee on Design and a member of the Task Force on Geometric Design. Through the Geometric Design Task Force, Don has worked on two editions of the Green Book, the Bicycle Guide, the Pedestrian Guide and Rest Area Guide. Don is also one of ALDOT's delegates on the AASHTO Standing Committee on Environment where he currently serves on its steering committee. Don currently serves on the TRB Committee on Geometric Design and is one of their representatives on the TRB Joint Task Force on Context Sensitive Design.

Mr. Arkle is a Past President of the Alabama Section of ITE and a Past President of the Montgomery Branch, and Alabama Section of ASCE. He is ASCE's representative to the Joint Engineers Council of Alabama. Don has also served as the Chairman of JECA.

Mr. Arkle lives in Prattville, Alabama with his wife Cindy and their four children. He is active in his community as well, serving on the Prattville Planning Commission and as Scoutmaster of Troop 111. Mr. Arkle and his family are also active members of Trinity United Methodist Church.

JERRY BLANDING is a graduate of Morgan State University with a B.S. degree in Civil Engineering. Jerry also received a Juris Doctor Degree from the University of Maryland. Jerry Blanding has over 10 years of experience as an innovative contracting engineer and six years with FHWA. His areas of expertise include infrastructure, innovative contract, contract administration and accelerated construction technology transfer as well as quality control and assurance. Jerry Blanding has an Environmental Law Certification from the University of Maryland, School of Law.

GARY L. BROWN is a graduate of Penn State University with a B.S. degree in Civil Engineering. Gary has been employed by the Federal Highway Administration (FHA) for 29 years and has 21 years of experience in highway construction management as a Project Engineer, Construction Operations Engineer, and Quality Assurance Engineer. Gary also has seven years experience in construction contract procurement as the Engineering Coordinator and one year as the Division Technology Coordinator responsible for identifying and deploying new technology.

AMAR A. CHAKER is Director of Engineering Applications at CERF, after serving as Director of ASCE's Transportation and Development Institute, and staff contact for several Divisions and Councils within ASCE's Technical Activities, including the Technical Council on Lifeline Earthquake Engineering and the Council on Disaster Reduction.

He has held faculty positions at the University of Illinois at Urbana-Champaign and Drexel University. He has served as Professor and Director of the Civil Engineering Institute of the University of Science and Technology of Algiers, where he conducted research funded by the European Commission and Algeria on the earthquake response of building structures, created the Earthquake Engineering Research Laboratory, and participated in post-earthquake investigations (Mexico City and Tipasa, Algeria) and in the seismic vulnerability study of Djelfa, Algeria. He has taught undergraduate courses in Structural Analysis and Structural Design and graduate courses in Dynamics of Structures, Earthquake Engineering, Probability Methods and Risk Analysis, and Finite Element Method for Structural Analysis, and supervised numerous graduate theses.

As Technical Director of the Organization for Technical Control of Construction, (CTC) in Algeria, he reviewed the design of complex structures and evaluated existing structures, checking their stability and safety with respect extreme events, and exerted technical oversight over a large number of civil engineers in charge of reviewing a variety of construction projects. He co-chaired the Committee for the Algerian Earthquake-Resistant Design Code, and participated in the development of the 1981, 1983 and 1988 editions. He participated in post-earthquake investigations (El Asnam earthquake) and in a seismic hazard evaluation and urban microzonation study for the region of El Asnam.

He served as a member of the Advisory Editorial Board of *Earthquake Engineering and Structural Dynamics*, and of the Editorial Board of *Annales Maghrébines de l'Ingénieur*. He was a Founding Member and President of the Algerian Earthquake Engineering Association. He is a member of the Earthquake Engineering Research Institute, the American Association for Wind Engineering and the American Society of Civil Engineers. He is a member of technical committees of ASCE's Technical Council on Lifeline Earthquake Engineering and Council on Disaster Risk Management. He is author or co-author of over 50 publications.

He holds a Ph. D. degree in Civil Engineering from the University of Illinois at Urbana-Champaign and a degree of 'Ingénieur Civil' from 'Ecole Nationale des Ponts et Chaussées', Paris, France.

STEVEN D. DEWITT is Director of Construction, North Carolina Department of Transportation - Mr. DeWitt is a 1984 graduate of The University of North Carolina at Charlotte with a Bachelor of Science in Civil Engineering. As Director of Construction he is responsible for activities related to contracting for construction of all major highway projects for NCDOT including contract lettings, specifications and standard drawings, utility relocations and designs, statewide administration of the NCDOT highway construction program, materials compliance, development of Traffic Control Plans, Design/Build activities, constructability and value engineering processes, and prequalification of private engineering firms and contractors. He has 20 years of experience with NCDOT in highway construction related roles.

He currently is Chairman of the Construction Section of the Transportation Research Board (TRB), a member and Past Chairman of the Committee on Construction Management, a member of the TRB Design/Build Task Force, a member of the AASHTO Subcommittee on Construction, Chairman of the AASHTO SOC Contract Administration Section, and Co-Chairman of the AASHTO Design/Build Task Force.

JOHN S. DICK is Structures Director on the Marketing Team at the Precast/Prestressed Concrete Institute in Chicago. He has been with PCI for 18 years. Until recently, he also served for 14 years as PCI's director of plant and personnel certification programs.

Before joining PCI, he spent 14 years in the precast concrete industry working at various positions in engineering and project management with companies located in Colorado, Iowa and Washington. In addition, he owned and operated a company located in Idaho that manufactured and sold explosives and provided custom blasting services.

Mr. Dick has a BS degree in Civil and Architectural Engineering from the University of Wyoming, Laramie, Wyoming. John represents PCI in all of their bridge-related activities including liaison with FHWA, AASHTO, TRB and the National Concrete Bridge Council. He is a member of the Transportation Research Board, American Segmental Bridge Institute and the American Concrete Institute. John is Managing Editor and Project Manager for the PCI Bridge Design Manual and plans and administers the annual National Bridge Conference. He has held positions on numerous industry committees. He is presently a member of the AASHTO Technology Implementation Panel on Prefabricated Bridge Elements and Systems. He served as Chair of the FHWA Research Review Committee on Strand Transfer and Development Length and served on the Advisory Committee during the development and evaluation of the FHWA Bridge Engineers Training Course.

ALAN FORSBERG is the Public Works Director for Blue Earth County, a County with a population of 55,000 urban and rural residents located about 80 miles southwest of Minneapolis / St. Paul, Minnesota. He has 20 years of experience with planning, funding, design, and construction of roads and bridges for local governments.

IAN M. FRIEDLAND was Bridge Technology Engineer for the Federal Highway Administration (FHWA) of the U.S. Department of Transportation (DOT) at the time this study was initiated. He is currently the Technical Director for Bridge and Structures R&D.

Prior to joining the FHWA in 2002, Mr. Friedland was Associate Director for Development with the Applied Technology Council (ATC), a nonprofit structural engineering organization concerned with natural and man-made hazards mitigation for the built environment, from 1999 – 2002; Assistant Director for Transportation Research at the Multidisciplinary Center for Earthquake Engineering Research (MCEER), from 1992 – 1999; and a Senior Program Officer with the National Academy of Science's Transportation Research Board, where he was in charge of all bridge research conducted in the AASHTO-sponsored National Cooperative Highway Research Program, from 1985 – 1992.

Mr. Friedland has been a member of numerous national task forces and advisory committees, including the FHWA Technical Advisory Committee responsible for the development of the FHWA-supported bridge management system PONTIS; the FHWA Task Force on Scaffolding, Shoring, and Formwork; the FHWA Research Council on Curved Bridges; and the AASHTO Special Task Force on Metrication. He is a registered professional engineer, and is a member of the American Society of Civil Engineers, the Transportation Research Board, currently serves on the Executive Committee of the ASCE Technical Council on Lifeline Earthquake Engineering, and recently stepped down Associate Editor of the ASCE Bridge Engineering Journal. Mr. Friedland received a Bachelor of Science degree in civil engineering from Cornell University in 1977 and a Master of Science degree in structural engineering and structural mechanics from the University of Maryland in 1978.

MICHAEL G. GOODE is the Vice President and Director, Industry Programs with Civil Engineering Research Foundation (ASCE). He has 35 years in urban transportation infrastructure - building, operating, maintaining, planning and designing - USA, Europe and Middle East, specializing in rail transit.

Civil engineering degree from University of Leeds, UK; MBA from George Mason University, Virginia; the Executive Program from University of Virginia, Darden Graduate School of Business; PE - Virginia, PMP – Project Management Institute Certification.

15 years building Washington DC's Metrorail system, 10 years in international transportation consulting with Parsons Brinckerhoff and CH2M HILL. 7 years leading TELFORD Consulting, focused on serving clients in pursuit of breakthrough performance improvement in sustainable, secure, and cost-effective, design, construction, operations & maintenance, of transportation infrastructure worldwide. Hallmark of this consulting practice was the adoption of asset management methods, including effective handling of security risks, and advocacy for the long-term stewards – the operations and maintenance teams – throughout the project and facility life-cycles.

Currently Mr. Goode is Director of Industry Programs at the Civil Engineering Research Foundation, a component of the American Society of Civil Engineers, where he is leading initiatives in infrastructure security, asset management, transportation, and capacity building for the infrastructure of the developing world.

At George Mason University in Virginia, Mr. Goode has supported creation of a Center for Homeland Security in the School for Information Technology and Engineering. The objective is to establish a center of excellence for consulting, education, and research in application of holistic, systems engineering approaches to developing and managing infrastructure in full consideration of all types of performance risk, including terrorism. Mr. Goode is also teaching graduate students both construction and facilities management at The George Washington University.

He is active at the local and national levels in the American Public Transportation Association, the Mid Atlantic States chapter of UK Institution of Civil Engineers, the American Society of Highway Engineers, the Transportation Research Board, and the American Society of Civil Engineers, where he recently chaired the Board's International Committee.

David Hohmann graduated from the University of Texas at Austin with a Bachelor of Science in Civil Engineering in 1982. David is the Director of Bridge Design for the Bridge Division of the Texas Department of Transportation (TxDOT). He has over 22 years experience in bridge design, all of it with the Texas Department of Transportation. David oversees the activities and direction for statewide bridge design in Texas. This includes both in-house design staff and evergreen bridge design consulting engineering firms. David is a member of TxDOT's structural Research Management Committee 5 and the National Cooperative Highway Research Program. David is also a member of both the AASHTO Technical Committee for Concrete Structures (T-10) and the AASHTO Technical Committee for Steel Design (T-14).

Cameron Kergaye is an Engineering Management Fellow at the American Association of State Highway and Transportation Officials (AASHTO) for the 2004 calendar year. He is responsible for research on technical and policy matters related to intelligent transportation systems, asset management, construction materials and geometric designs of highways. He is involved in several domestic and international information exchange programs in coordination with the Federal Highway Administration and the National Cooperative Highway Research Foundation, and he is a liaison for AASHTO's Special Committee on International Activity Coordination.

Prior to his fellowship position at AASHTO, Cameron was a professional engineer for 12 years at the Utah Department of Transportation (UDOT) where he managed several engineering groups: consultant engineering services, value engineering, access management, statewide permitting, and the utilities and railroad divisions. Cameron was also Quality Manager on Utah's $1.6 billion Design/Build project for the 3 years leading to the 2002 Olympics in Salt Lake City. Early in his career with UDOT he was a Materials Engineer for 5 years and was responsible for the quality and management of several State laboratories.

His educational background is primarily in Civil Engineering where he holds a Bachelor and Master of Science degree from the University of Utah. He also holds a Bachelor of Arts degree in the Humanities. Cameron is a recipient of quality service awards for achievements Design/Build and design engineering services. He has authored numerous publications on construction materials, laboratory quality, traffic analysis, and access management.

Robert Kogler is currently Team Leader for Bridge Design & Construction Research for the Federal Highway Administration (FHWA). In this capacity he is responsible for development and oversight of FHWA's research and technology transfer efforts in the area of advanced, high performance materials for bridges, and corrosion protection for structures. Mr. Kogler has been with FHWA for eight years, during which time he has headed the corrosion protection technology program for steel bridges. Specifically his expertise lies in the test and evaluation of corrosion protection materials and coatings and in development of corrosion protection programs for steel bridges. Prior to coming to FHWA, Mr. Kogler spent seven years in the consulting engineering field focusing on corrosion engineering. He has extensive experience in corrosion protection applications in the marine industry including significant coating and cathodic protection design work for the US Navy. Mr. Kogler is also currently President of SSPC: The Society for Protective Coatings, and is a Past President of the Washington Paint Technical Group, both professional technical societies. Mr. Kogler holds a degree in Materials Science and Engineering from the University of California, Berkeley.

Jon Magnusson is Chairman/CEO of Magnusson Klemencic Associates, Inc., leads what many people consider one of the most creative consulting engineering firms in the country.
He is a Summa Cum Laude graduate of the University of Washington and earned his Masters at the University of California, Berkeley. He was elected as an officer in the company at the age of 29 and CEO at the age of 34. In the following eighteen years the firm has received thirteen national engineering excellence awards for innovation and quality from the American Council of Engineering Companies.

Jon has been the Structural Engineer-in-charge on $2-billion worth of construction projects in the last five years alone. His projects include engineering landmarks such as Safeco Field, Hawaii Convention Center, Qwest Field, Benaroya Hall, Experience Music Project, Key Arena, and the Seattle Public

Library. He consults to many of the world's architectural "stars" including Frank Gehry and Rem Koolhaus.

The reach and impact of the firm is worldwide with projects in 44 states and 35 countries. The firm has performed the structural engineering for more than 60 high-rise buildings in the last 15 years. His travel now exceeds a total 1.7 million air miles (equivalent of almost 80 times around the globe), visiting 37 states and 26 countries.

Jon has published 30 articles and papers in both technical and popular media. He is in high demand as a speaker, with 130 presentations completed for both engineering and non-technical groups. After the attack on the New York World Trade Center, Jon was sought out by all forms of print and broadcast media to help explain what had happened and what the events mean for the design of buildings in the future. He granted more than 100 media interviews including ABC Evening News with Peter Jennings, Discovery Channel, BBC, NPR, History Channel, Wall Street Journal, New York Times, Good Morning America, NBC News, CBS News with Dan Rather, and many others.
His community activities have focused on service to youth programs and Children's Hospital and Medical Center.

MAHENDRA G. PATEL assumed his duty as Chief Engineer at Pennsylvania Department of Transportation (PennDOT) in December 2003. He leads four Highway Administration Bureaus in establishing and implementing Department-wide policies, criteria, standards and procedures for the highway system to assure statewide conformation and uniformity. Major functionalities of his area include project/program delivery, procurement of engineering and construction contracts, transportation maintenance and operations, and system performance evaluations.

Prior to re-joining PennDOT, Mr. Patel headed the construction arm of Hersha Enterprises from July 1999 until November 2003. At Hersha he oversaw general construction of motels, upscale residential homes, public schools, restaurants, etc. worth approximately $30 million per year. His company performed construction management, owner representative duties and general contractor functions.

Prior to joining the Hersha Group, he was Director of the Bureau of Design in PennDOT. In this capacity, he was responsible for all activities starting from initiation of highway and/or bridge design to start of construction which encompassed retaining design consultants and construction contractors, environmental clearance, completion of design and bid documents, securing right-of-way for projects, bidding projects, and executing all contracts worth as much as $1.3 billion per year. During his tenure of over 30 years with PennDOT, he designed over 200 bridges and culverts, coordinated/expedited multi-year bridge and Interstate highway construction programs with a combined value of $2-3 billion, and also served as the Chief Bridge Engineer. He also served on numerous state and national professional organizations as a member, director, secretary, or chairman, and received numerous recognition awards.

He received his post graduate degree in structural engineering from Brigham Young University, Utah, and bachelors' degree from M.S. University, India. He is a registered Professional Engineer and Professional Surveyor in Pennsylvania.

CHERYL ALLEN RICHTER is a Pavement Technical Coordinator for the Highways for LIFE Team at the Federal Highway Administration. Her past positions at the Federal Highway Administration include Team Leader for Portland Cement Concrete Pavement Research and Development, Long Term Pavement Performance Program. She has also held positions with the Strategic Highway Research Program and New York State Department of Transportation. Ms. Richter holds a Bachelor of Science and a Master of Science from Cornell University as well as a Ph.D. from the University of Maryland. Ms. Richter is a Professional Engineer in the State of Maryland.

APPENDIX B – LOCAL ORGANIZING COMMITTEES

Local Organizing Committees assisted CERF in organizing the meetings. CERF enlisted the help of senior executives of companies that are members of its Corporate Advisory Board. Local Group Leaders were identified in each of the three metropolitan areas. They provided invaluable assistance by identifying the key players in vertical and horizontal construction in their area and inviting them to participate in the meetings as presenters, discussants, moderators, or guides for field trips.

The members of the New York City, Chicago and Los Angeles Organizing Committees are listed the following Tables. The three Local Group Leaders are identified by an asterisk.

Table B.1. New York City Organizing Committee

Name	**Organization**
David Palmer*	Arup
Nancy Hamilton	Arup
David Scott	Arup
Jeremy Isenberg	Weidlinger Associates
Jon Magnusson	Magnusson Klemencic Associates
Jim Lammie	Parsons Brinckerhoff
David Thurm	New York Times
Charles DeBenedettis	Tishman-Speyer
James Dall	New York Dormitory Authority
John Reed	Bechtel

Table B.2. Chicago Organizing Committee

Name	**Organization**
William Baker*	SOM
John Viise	SOM
Bill Moody	The John Buck Company
Harry Walder	Walsh Construction
Ross Wimer	SOM
John Zils	SOM
Alice Hoffman	Hoffman Management Consultants
Mark Simonides	Turner Construction
Joe Burns	Thornton Tomasetti
Joe Dolinar	Lohan Caprile Goettsch Architects
John Padoven	Bentley Systems
Kristine Fallon	Kristine Fallon Associates, Inc

Table B.3. Los Angeles Organizing Committee

Name	Organization
Ed McSpedon*	HNTB
Tony Gonzales	HNTB
Gerry Seelman	DMJM-HARRIS (AECOM)
Jon Magnusson	Magnusson Klemencic
Matt McDole	E-470 Public Highway Authority
Jay Allen	Seismic Structural Design Associates
Terry Dooley	Retired; formerly, Morley Construction
Marc Kersey	Clark Construction
Jim Glymph	Gehry Partners
Ben Schwegler	Disney Imagineering

APPENDIX C – FRAMEWORK FOR DATA COLLECTION

The members of the Scan Team prepared a set of questions that were provided to the Local Organizers in each city ahead of time. These questions allowed the Local Organizers to identify key participants and to prepare presentations and collect documentation to assist in the primary areas of information-gathering that the Scan Team was interested in. The questions that were prepared are as follows:

Core-Issue Questions

1 - Moving Innovation into Practice
In addition to the fact that the vertical construction world is predominantly private sector, what other 'environmental' differences are engendered by the vertical construction marketplace that facilitate innovation?

2 - Improving Design and Construction Productivity
In the vertical construction world, what factors exist that facilitate greater efficiency and productivity in developing buildings?

3 - Meeting Facility Performance (including business performance) and Quality Objectives over the Life-Cycle
How in the vertical construction world do the participants ensure their decisions are contributing positively to the life-cycle quality and performance of the facility?

Detailed questions

The highway and bridge community is seeking answers to the following more detailed questions:

1. In the vertical construction business, what are the key factors in stimulating innovation that results in better, faster, and/or cheaper in:
   a. Materials
   b. Installed equipment and systems
   c. Use of technology for design process and construction process enhancement
   d. Means and methods of construction
   e. Contracting
   f. Regulatory compliance
   g. Workforce teamwork and efficiency
   h. Durability and reliability of materials, systems, and equipment
   i. Aesthetics

      How does including aesthetics in building construction contribute to the value of the project?

      How do you establish aesthetic enhancements which have a public consensus for being valuable?

2. What are the candidate acquisition strategies typically examined for construction projects in your business?
   a. What drives the process of selecting a strategy?
   b. Do you standardize on one approach, such as Design-Bid-Build, and only deviate as special conditions dictate?
   c. How much is the final design aggregated with the construction in one contract and what approaches are used to defining the parameters of this approach? Is the preliminary design team deliberately separate?

d. How much do you use fixed price lump sum bidding?
e. Is operation and/or maintenance ever included in the construction package and if so, what objectives are established and what would drive such decisions?
f. To what extent is qualifications-based selection used for construction contracting?
g. How do you look for faster…..cheaper…..better? And do you really achieve all three?

3. Participants in our scanning study include agencies with portfolios of bridge and highway projects typically much smaller than the average State DOT projects. For smaller projects, what factors are different in the approach to planning, acquisition, design and construction, commissioning, and maintenance, in the vertical construction business?

4. In the design and construction phase(s) of project development, how does the vertical construction sector keep the project objectives before the stakeholders and participants, including:

   a. facility business model and life-cycle parameters
   b. maintenance objectives
   c. sustainability objectives
   d. aesthetic objectives
   e. commissioning requirements
   f. maintenance of capacity during construction (in and around the construction activity)
   g. warranty requirements of owners

5. How, in the vertical construction sector, do the owner and contractor teams define their respective roles and responsibilities in the following activities:
   a. Plans and specifications
   b. Quality Assurance and quality control
   c. Inspection
   d. Warranties
   e. Payments
   f. Contracting (including comment on 'lowest price', 'A+ bidding', and 'incentives and disincentives'
   g. Leased versus owned

6. How is the new focus on security and safety affecting the vertical construction business?
   a. How are you handling the new threats of terrorism and the indeterminate nature of the probability and character of potential attacks?
   b. Are you planning additional expenditures on hardening the facilities?
   c. Are you planning to handle the perceived increased risk with added operational security (staff and CCTV, for example)?
   d. How are you integrating the scenario-planning for security with the risk assessment of other hazards or vulnerabilities?
   e. What influence is your insurance underwriter having on the decisions you make in this regard?

To handle the inevitable up and down cycles in your business, how do you achieve the necessary flexibility in staffing and labor, across the industry participants: managers, architects and engineers, construction managers and trades, operations and maintenance professionals and staff?

7. We all understand how critical good project management and honed project management processes are to the whole development and construction cycle. In the vertical construction business how do you secure the right skills and shape them into meeting your specific needs?
    a. Invest in standard certification processes (eg. PMI) or build in-house certification and training programs?
    b. Invest in standard (Commercial Off-the-Shelf Software or COTS) software and systems or build your own?
    c. Provide incentives for staff performance – how?
    d. Do you practice a womb-to-tomb assignment of managers vis-à-vis specific projects? Or do you have the special teams approach? Or other?

8. How has the separate activity of 'commissioning' caught on in the vertical construction world?
    a. Are you retaining specialty consultants or systems integrators to perform this function?
    b. How well are the Operations and Maintenance (O&M) stakeholders responding to this new approach?
    c. How otherwise are you achieving success (or not) in this critical phase of the construction cycle?

9. In the planning, programming, and financing stages of your construction projects:
    a. Who are the participants; do they include your maintenance and operations teams; your construction teams, your architects and design engineers?
    b. How much emphasis is on life-cycle cost?
    c. What role does sustainability play in decision-making?
    d. How well is the business model for the facility itself disseminated among the team members involved in this stage of decision-making?
    e. How far-reaching is the search for financing, and does it typically include all the participants, including the construction team as a potential investor?

APPENDIX D – MEETING AGENDAS

D.1 – NEW YORK CITY

Location:	Weidlinger Associates, Inc. 12th Floor 375 Hudson Street New York, NY 10014-3656
Dates:	July 7-8, 2004

Program:

Wednesday July 7

9:00 pm	Informal meeting – Review logistics & agenda for July 8-9 Southgate Tower Hotel (Registration Desk)

Thursday July 8

7:00 am to 8:00 am	Registration and continental breakfast
7:30 am	Welcome - Ian Friedland, FHWA Welcome – Cameron Kergaye, AASHTO Keynote – Charles Thornton, Thornton-Tomasetti (Summary by Mike Goode) Program review with objectives and process – Mike Goode, CERF Self-introductions
8:30 am to 10:00 am	***Innovation and Productivity*** *Moderator/Facilitator:* Jim Lammie, Parsons Brinckerhoff *Presenters:* Jim Lammie – Previous TRB Initiatives on Highway Construction Innovation and Thoughts on Sustainability Jeremy Isenberg, Weidlinger Assoc. – Innovation Examples Jon Magnusson, Magnusson-Klemencic – Innovation Examples Charles DeBenedittis, Tishman-Speyer – Owner Perspective *Discussants:* Kevin Barnett, Turner Construction Peter Bernstein, Turner Construction
10:00 am to 10:30 am	Refreshment break
10:30 am to 12:30 pm	Working session with facilitator (Jim Lammie)
12:30 pm to 1:30 pm	Lunch *Keynote speaker:* Frank Lombardi, Port Authority of New York and New Jersey
1:30 pm to 3:00 pm	***Facility Performance Issues***

	Moderator/Facilitator: Dave Palmer, ARUP *Presenters:* James Dall, New York Dormitory Authority David Scott, ARUP Nancy Hamilton, ARUP *Discussant:* Jim Lammie
3:00 pm to 3:30 pm	Refreshment break
3:30 pm to 5:30 pm	Working session with facilitator (Dave Palmer)
6:00 pm to 8:00 pm	Dinner at Oro Blue Restaurant (adjacent to Weidlinger Office)

Friday July 9

7:00 am to 8:00 am	Breakfast at Southgate Hotel
8:00 am to 1:00 pm	***Field trip*** Bus departs hotel at 8:00 am and returns us to Weidlinger Office meeting space at 1:00 pm Jamaica Station Air Train – John Reed, Bechtel Kennedy Airport Terminal 4 – Nancy Hamilton, ARUP NY Times Building Mock-up – Glen Hughes, New York Times
1:00 pm to 2:30 pm	Working lunch at Weidlinger Associates – Reports and interim conclusions (David Palmer attending)
2:30 pm to 3:00 pm	Feedback – Lessons learned for next scan trip
3:00 pm	Adjourn

D.2 - CHICAGO MEETING

Location:	Skidmore, Owings & Merrill, LLP (SOM) 8th Floor 224 S. Michigan Chicago, IL 60604
Dates:	August 5-6, 2004
Program:	

Wednesday August 4

9:00 pm	Informal Meeting – Review logistics & agenda for August 5-6 Hotel Sofitel Chicago Water Tower (Registration Desk)

Thursday August 5

7:00 am to 8:00 am	Registration and continental breakfast at meeting location
8:00am to 9:00 am	Welcome – Bill Baker, SOM – Local Team Leader Welcome – Ian Friedland, FHWA Welcome – Cameron Kergaye, AASHTO Keynote – Charlie Thornton, Thornton-Tomasetti (by telecom) Program review: objectives and process – Mike Goode, CERF Self-introductions
9:00 am to 10:30 am	***Innovation and Productivity in Planning, Design, Construction*** *Moderator/Facilitator – Tom Kerwin, SOM* *Presenters:* Bill Moody – The John Buck Company Harry Walder – Walsh Construction - General Contractor and Concrete Subcontractor Ross Wimer – SOM Design Partner John Zils – SOM Senior Structural Engineer Kristine Fallon – Kristine Fallon Associates, Inc. *Discussants:* Ron Burg – Concrete Technology Laboratories Tom Schlafly – AISC Michael Pfeiffer – International Code Council David Shier – Walsh Construction
10:30 am to 11:00 am	Refreshment break
11:00 am to 12:30 pm	Working session with facilitator
12:30 pm to 2:00 pm	Lunch (meeting room) *Keynote speaker:* Henri Petroski, Duke University
2:00 pm to 3:30 pm	***Facility Performance, Influence on Design and Construction***

	Moderator/Facilitator: Joe Burns, Thornton-Tomasetti *Presenters:* Alice Hoffman, Hoffman Management Consultants – Owner Mark Simonides, Turner – Construction Manager Joe Burns, Thornton Tomasetti –Structural Engineer Joe Dolinar, Lohan Caprile Goettsch – Architect John Padoven - Bentley Systems
3:30 pm to 4:00 pm	Refreshment break
4:00 pm to 5:30 pm	Working session with facilitator
6:00 pm to 8:00 pm	Dinner at Papagus restaurant

Friday August 6

7:00 am to 8:00 am	Continental breakfast at meeting location
8:00 am to 12:30 pm	***Field trip*** Soldier Field (Joe Dolinar – Lohan Caprile Goettsch) 1 S. Dearborn – (HKSE)
12:30 pm to 1:30 pm	Lunch (meeting space)
1:30 pm to 2:30 pm	Working session – Reports and interim conclusions
2:30 pm to 3:00 pm	Feedback – Lessons learned for next scan trip
3:00 pm	Adjourn

D.3 - LOS ANGELES MEETING

Location:	AECOM DMJM+Harris The Hastings Building, North Tower 515 South Flower Street, 9th Floor Los Angeles, CA 90071-2201
Dates:	September 22-23

Program:

Tuesday September 21

9:00 pm	Informal meeting – Review logistics & agenda for September 22-23. Bonaventure Hotel (Registration Desk)

Wednesday September 22

7:00 am – 8:00 am	Registration and continental breakfast AECOM, White Projection Room
8:00 am – 9:00 am	Keynote – Charles Thornton, Thornton-Tomasetti (by telephone) Welcome – Ed McSpedon, HNTB – Local Team Leader Welcome – Gerry Seelman, AECOM DMJM+Harris Welcome – Ian Friedland, FHWA Welcome – Cameron Kergaye, AASHTO Program review: objectives and process – Mike Goode, CERF Self-introductions
9:00 am – 10:30 am	***Innovation and productivity in planning, design, construction*** *Moderator/Facilitator: Gerry Seelman, AECOM* Innovations in the E-470 project -New Transportation & Development Institute Survey Matt McDole, E-470 and ASCE Transportation & Development Institute Innovations at the Los Angeles. Department of Transportation Dr. Frankie Banerjee, formerly Chief, Los Angeles Department of Transportation *Discussants:* Tom Verdi – Charles Pankow Builders Ed McSpedon – HNTB Gerry Seelman – AECOM Tom Dooley – Morley Construction (Retired)
10:30 am – 11:00 am	Refreshment break
11:00 am – 12:30 pm	***Discussion session***

12:30 pm – 2:00 pm	Lunch (meeting room) *Keynote speaker:* Gil Garcetti, author of *Iron: Erecting the Walt Disney Concert Hall* Erecting the Walt Disney Concert Hall
2:00 pm – 2:15 pm	Refreshment break
2:15 pm – 3:30 pm	***Facility performance issues, influence on design and construction*** *Moderator/Facilitator:* Ed McSpedon, HNTB Innovations at the Los Angeles Unified School District Tim Buresh and Jim Connell, Los Angeles Unified School District Advances in Passive Energy Dissipation and Practical Application to Protect Intellectual Heritage, Essential and Historical Buildings Owen Hata, Nabih Youssef & Associates The Slotted Web Moment Connection – Introducing an Innovation into the Vertical & Horizontal Construction Market Places Robert Partridge, Seismic Structural Design Associates, Inc. / Smith-Emery
3:30 pm – 3:45 pm	Refreshment break
3:45 pm – 4:30 pm	***Presentation & discussion session***
4:45 pm	Board bus for Gehry Partners Studio Visit
5:30 pm – 7:30 pm	Gehry Partners Studio Visit (Jim Glymph) Gehry Technologies (Malcolm Davies)
8:00 pm – 9:30 pm	Group dinner – The Chart House, Redondo Beach
10:30 pm	Return to hotel

Thursday September 23

7:00 am - 8:00 am	Breakfast (meeting location)
8:00 am – 12:00 pm	***Working session – Los Angeles meeting summary*** Project wrap up: interim conclusions/summary of findings; plans going forward for hand-off and reporting
12:00 pm – 1:30 pm	Lunch *Lunch speaker:* William Cook, URS Using 4-D: UCLA-Santa Monica/Orthopedic Replacement Hospital, Harbor-UCLA Medical Center Olive View Medical Center
1:30 pm – 4:30 pm	***Field trip***

	Los Angeles Cathedral (Cast-in-place concrete, base-isolated structure) – Terry Dooley, Morley Construction Caltrans Headquarters (Green Building) – Marc Kersey, Clark Construction Walt Disney Concert Hall – Self-guided tour
4:30 pm – 5:30 pm	Executive summary and report outline - Wrap up (meeting location)
5:30 pm	Adjourn
6:00 pm – 8:00 pm	Group Dinner Bonaventure Hotel Brewing Company – Pool Deck Level

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