

## **The Application of Function Analysis System Technique for Program Management**

Function Analysis System Technique, better known as FAST Diagramming, is well understood regarding its use on technology focused applications ranging from manufactured products to construction projects. While FAST has been applied to business processes and human management and organizational systems, there is in general a dearth of literature regarding techniques pertaining to these types of applications.

Recently, the authors facilitated a Value Management study that focused on improving the products and services delivered by an entire program within the California Department of Transportation (Caltrans). Specifically, the study examined the Division of Transportation Planning (DOTP). This paper will explore the challenges of applying FAST to large, diverse programs such as Caltrans DOTP and present techniques and lessons learned. Further, the authors will share insights into how function analysis directly led to a specific solution to solve a major problem.

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## **Introduction**

Function Analysis System Technique, better known as FAST Diagramming, is well understood regarding its use on technology focused applications ranging from manufactured products to construction projects. While FAST has been applied to business processes as well as management and organizational systems, there is in general a dearth of literature regarding techniques pertaining to these types of applications.

Recently, the authors facilitated a Value Analysis (VA) study that focused on improving the products and services delivered by an entire program within the California Department of Transportation (Caltrans). Specifically, the study examined the Division of Transportation Planning (DOTP). Caltrans, as an organization, is divided into 12 regions statewide, known as districts, which operate under the oversight of headquarters located in Sacramento. The myriad products and services that DOTP provides varies regionally based upon the differing needs of the various transportation partners that each district. Function analysis and FAST were applied early in the study to better understand the key programmatic drivers within DOTP.

This paper will explore the challenges of applying FAST to large, diverse programs such as Caltrans DOTP and present techniques and lessons learned. Further, the authors will share insights into how function analysis directly led to a specific solution to solve a major problem.

## **Program Overview and Challenges**

The Caltrans is undergoing critical internal and external reviews in order to trim the state's budget. Currently, DOTP and planning related programs are being assessed to identify cost reduction opportunities. This has already resulted in the downsizing of advance planning activities to develop Project Initiation Documents (PID) and other planning related cuts. It has been a challenge to explain to external agencies how existing Caltrans Planning activities support Caltrans' and its partner's goals to improve mobility. There is a need to address disconnections between the actual planning activities and the descriptions of documents and service for securing budgetary authority. It is critical that DOTP can illustrate how planning activities support critically vital statewide, regional and interregional mobility improvements.

Transportation planners are facing daunting challenges to address new technologies, regulations, and environmental and social challenges. These include (but are not limited to):

- Climate Change
- Alternative Fuels
- Complete Streets
- Shifting Demographics
- Congestion Pricing
- High Speed Rail

Additionally, transportation planners are challenged with declining federal, state, and local revenues and the near build-out of the interregional highway network, particularly in the metropolitan areas. All these factors require that Caltrans strategically reassess how to successfully evolve in order to meet these challenges working in partnership with our transportation partners and stakeholders.

Transportation planners have an opportunity to reassert the importance of planning skills and tools to deliver a comprehensive analysis of system deficiencies and solutions. Planners need to seize the reins of leadership to advance mobility improvements and the ensuing economic and social benefits realized by an effective and efficient transportation network.

The broad objective of the VM study was to support the statewide discussions and decision-making for comprehensive improvement reforms. More specifically, the goal of this VA effort was to examine the overall value of transportation planning and look for approaches to better communicate the essential benefits and risks associated with inadequate planning. In addition, the VM participants brainstormed, evaluated, and developed implementation plans to improve the DOTP's methods, products, and services.

### **VA Study Structure**

One of the major challenges of this study is the fact that each district within Caltrans is unique in terms of the geography, weather, politics, and highway facilities. This means that the services that Caltrans Transportation Planning provides vary significantly for each district. In order to ensure that the VA Study will address the individual needs of each district, it was determined that a series of regional information gathering workshops should be held in order to capture as much information as possible and to compare and contrast the products and services provided on a statewide basis. The one-day information gathering workshops included:

- South Region – San Diego
- Central Region – Fresno
- North Region – Sacramento

Each workshop included representatives from each district as well as from headquarters. During these workshops, the following activities were conducted that covered the Information and Function phases of the VA Job plan.

- Identification of Customers, Products and Services
- SWOT Analysis
- Review of Survey Results
- Risk Assessment
- Analysis and Prioritization of Planning Functions

A formal Value Analysis study will follow to perform the Creativity, Evaluation, Development and Presentation phases of the VA Job Plan and the information developed during these initial workshops was be used to focus the VA team's subsequent efforts.

### **Application of Function Analysis**

As part of the information gathering workshops, the various functions related to Caltrans Transportation Planning were identified and a number of FAST diagrams were developed that detail the relationships of these functions. Further, a sub-set of basic functions were identified and the workshop participants were asked to prioritize these based on their importance.

The first step in the function analysis process is to identify functions. Each workshop focused on different functional areas of planning. The process focused on first identifying the various services, products and activities involved with planning. The team then identified the two-word function definitions that explained the “whys” of these. The table provided below summarizes this initial random function determination effort.

To provide an example, let us examine a budgeting and invoicing process. Let us assume that one of the activities involved in the work breakdown structure (WBS) is “to develop a budget based upon a scope of work.” Using the two-word abridgement syntax of function analysis, one could easily convert the aforementioned activity into a function statement such as “Create Budget.” Now this follows the rules of verb + noun syntax, however, it really just describes what the activity is, not why it is done. Thinking deeper about what the function of a budget is, one would likely conclude that budgets essentially serve as estimates of work that have yet to be performed. Therefore, a more representative functional expression of creating a budget would be to “Estimate Work.”

This type of thinking was broadly applied to various Caltrans Transportation Planning activities. It is important to remember that functions are not objects or activities, but rather, metaphysical descriptions of why those things exist. The process of function analysis forces participants to disassociate the things and activities they deal with on a daily basis and instead focus on the reasons for why they exist. Once these functions have been isolated, it expands opportunities for creative and innovative solutions by empowering teams to seek alternative ways of accomplishing functions and moves thinking away from existing solutions. Table 1 below provides an example of the results of the random function determination for two specific planning areas, system planning and funding advocacy.

The workshop participants used the functions identified in the random function determination to construct a series of FAST diagrams to identify the causal relationships between functions in a graphic way. What follows are two specific FAST diagrams that relate to the areas of systems planning and funding advocacy. With respect to system planning, one of the major planning activities is the development of a product known as a Transportation Concept Report (TCR). With respect to the area of funding advocacy, one of the major planning activities is the administration of a program referred to OWP (Overall Work Program). The OWP is primarily concerned with disbursing transportation funds to local public entities.

During the construction of the FAST diagrams, new functions were discovered and some were discarded as duplicate functions. The FAST diagrams for each are presented in Figures 1 and 2 below. In addition to the diagrams, another ten FAST diagrams were prepared that addressed additional planning areas and activities.

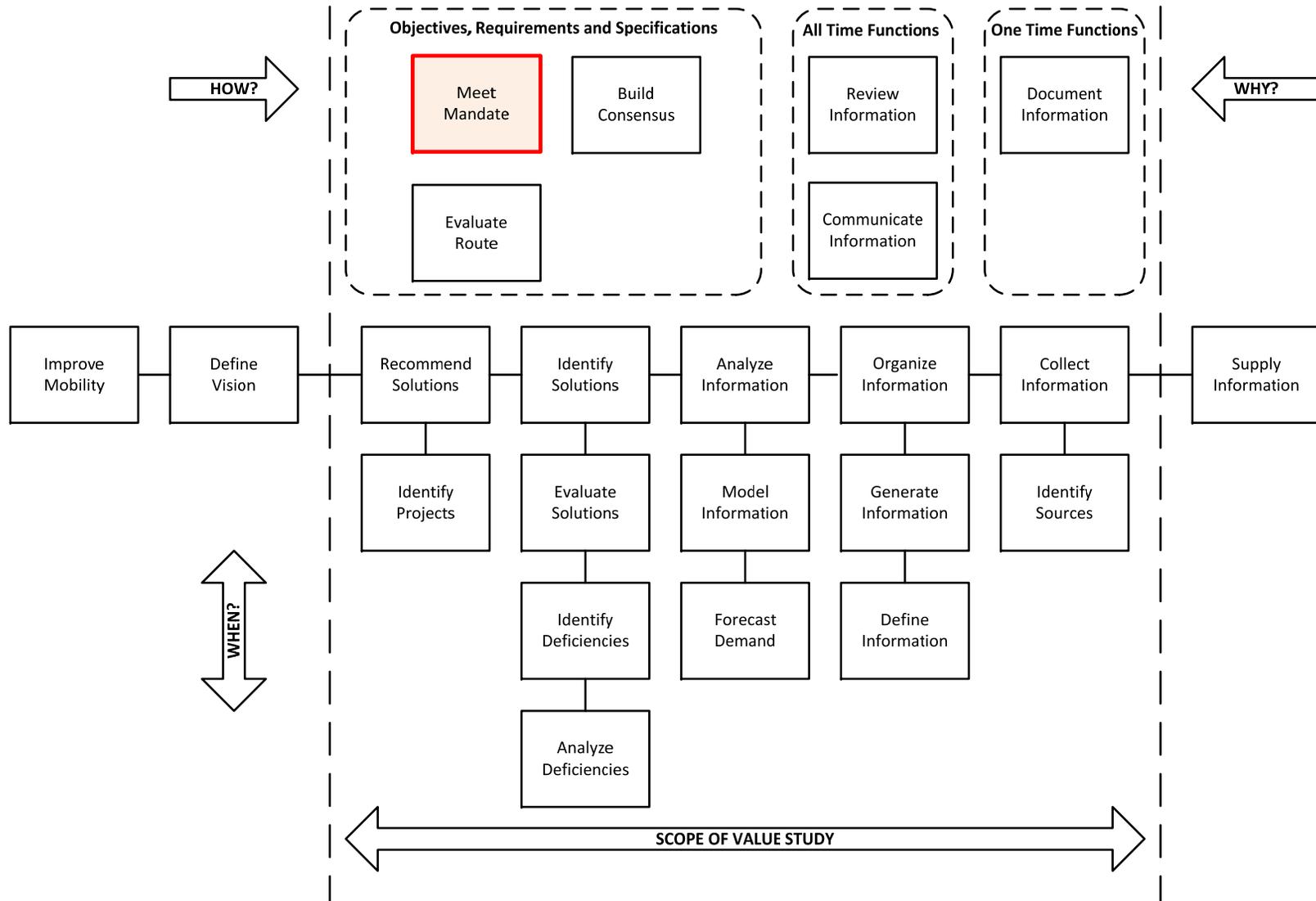
Once the FAST diagrams had been developed for each of the discrete planning areas, these were combined to synthesize a single FAST diagram that represents all of the key functions involved in the Caltrans Transportation Planning Program. One of the key discoveries was that seven basic functions emerged that were essentially tied to two major higher order functions.

<b>Planning Element</b>	<b>Function</b>
System Planning	Prioritize Solutions
System Planning	Identify Deficiencies
System Planning	Collect Data
System Planning	Analyze Data
System Planning	Generate Data
System Planning	Model Data
System Planning	Identify Projects
System Planning	Define Criteria
System Planning	Evaluate Solutions
System Planning	Improve Decisions
System Planning	Recommend Solutions
System Planning	Define Purpose & Need
System Planning	Align Purpose & Need
System Planning	Communicate Purpose & Need
Systems Planning	Meet Mandate
Systems Planning	Identify Deficiencies
Systems Planning	Recommend Solutions
Systems Planning	Analyze Data
Systems Planning	Collect Data
Systems Planning	Generate Data
Systems Planning	Define Vision
Systems Planning	Model Data
Systems Planning	Forecast Demand
Systems Planning	Analyze Deficiencies
Systems Planning	Identify Solutions
Systems Planning	Evaluate Solutions
Systems Planning	Build Consensus
Systems Planning	Define Data
Systems Planning	Identify Sources
Systems Planning	Communicate Information

<b>Planning Element</b>	<b>Function</b>
Funding Advocacy	Secure Funds
Funding Advocacy	Request Funds
Funding Advocacy	Justify Funds
Funding Advocacy	Identify Criteria
Funding Advocacy	Identify Needs
Funding Advocacy	Promote Needs
Funding Advocacy	Manage Funds
Funding Advocacy	Fund Projects
Funding Advocacy	Build Consensus
Funding Advocacy	Define Projects
Funding Advocacy	Program Funds
Funding Advocacy	Expedite Delivery

**Table 1 – Functions of System Planning and Funding Advocacy**

## TCR Development – FAST Diagram



**Figure 1 – FAST diagram of TCR Development**

### Administer OWP – FAST Diagram

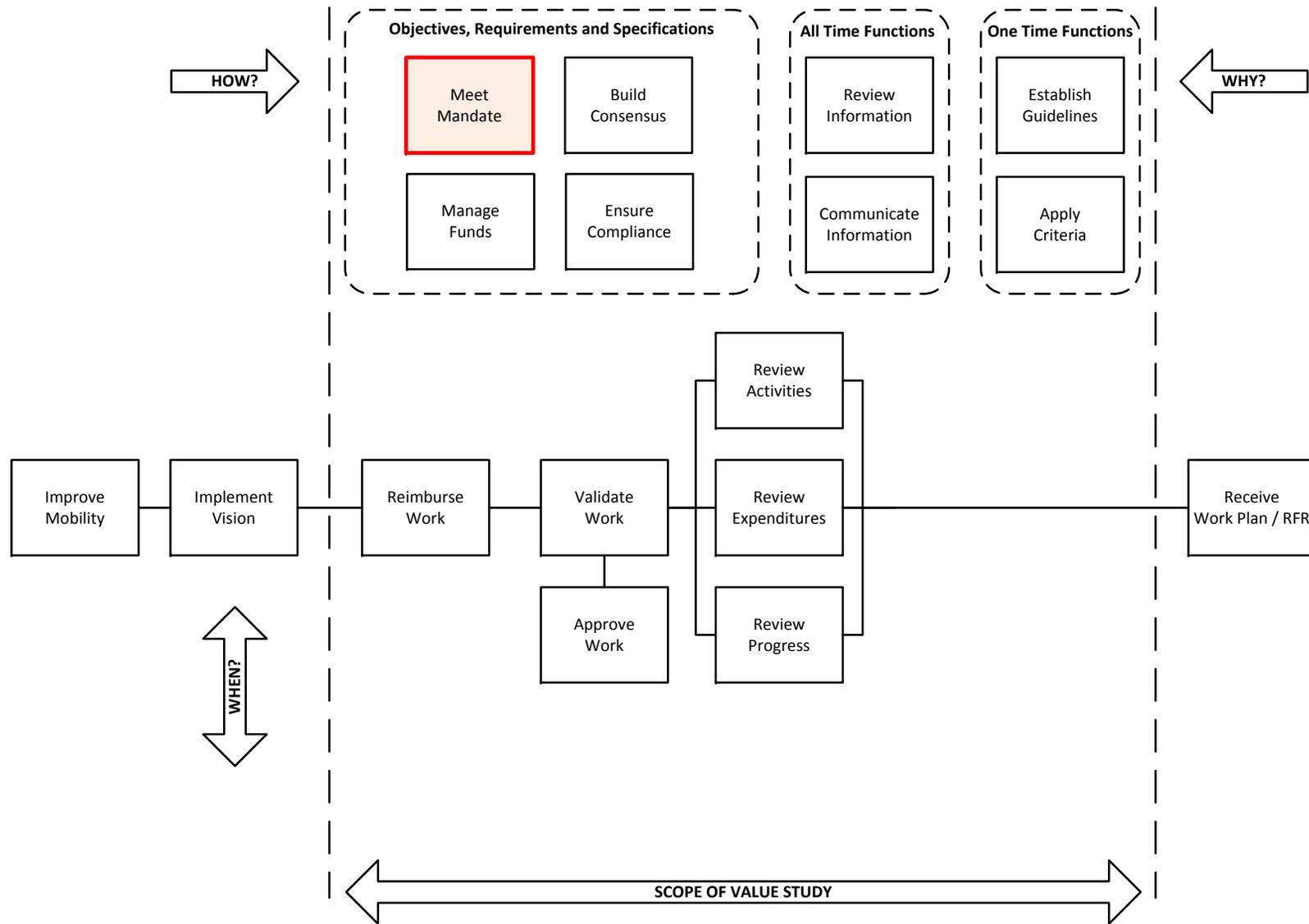


Figure 2 – FAST diagram of OWP Administration

The basic functions distilled down to the following:

- Recommend Solutions
- Recommend Strategies
- Align Strategies
- Recommend Mitigation
- Recommend Improvement
- Prioritize Projects
- Reimburse Work

These basic functions in turn addressed the higher-order functions of:

- Define Vision
- Implement Vision

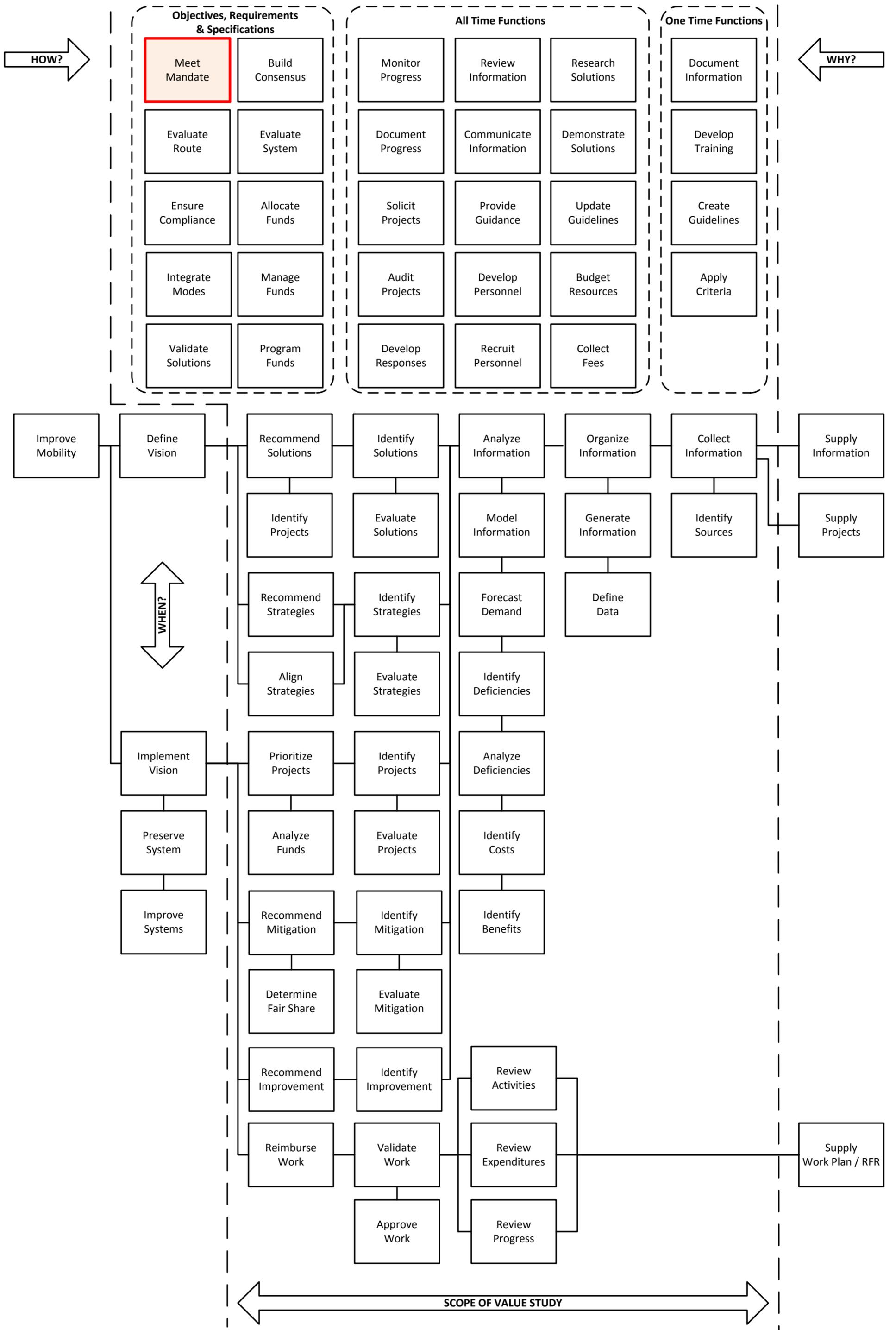
These in turn supported the basic mission of Caltrans, which was already eloquently stated in functional terms as “Improve Mobility.”

Further, what struck the participants in the workshop was how many of the various planning products that DOTP delivers are functionally similar but are manifest in different ways. Another functional objective that appeared in many of the individual FAST diagrams was “Meet Mandate.” This function represented the belief that many of the specific planning documents (products) delivered by DOTP were legislatively mandated by the State of California. This led to much deeper discussions about what this meant. After additional analysis and research was performed, it was determined that while indeed the functions of the planning documents were mandated, most of the actual activities and the products themselves were not. This meant that it was possible to investigate ways of redeveloping these planning documents into new DOTP products that would be more relevant, consolidated and optimized to meet the changing transportation planning needs of state and local governments. The combined FAST is provided in Figure 3, which is indeed quite large, however, it is much simpler than one might think.

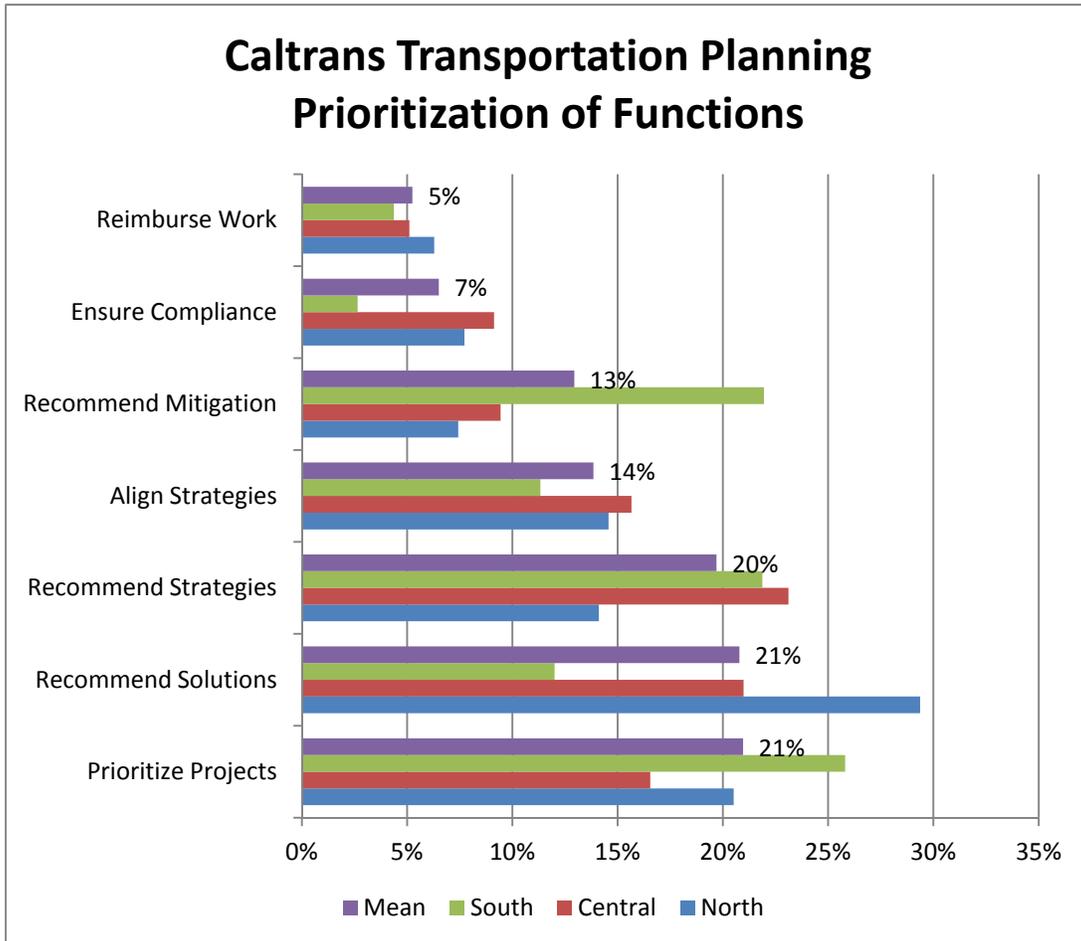
The process of breaking down the various planning areas into discrete FAST diagrams and then synthesizing these areas into a programmatic FAST diagram allowed the team to envision how their various, daily planning functions and activities fit into a broader, functional context with respect to the program as a whole.

Participants in each workshop were asked to prioritize the importance of key planning functions identified during the function analysis. This was achieved by using the method of Analytic Hierarchy Process (AHP) paired comparisons to derive the priorities. The participants used remote control keypads to directly input their personal priorities. The group’s ratings were made visible to all and the rationale for the paired comparisons was discussed with the participants. This process provided additional insight and helped deepen the level of understanding behind the participant’s thinking.

# Caltrans Transportation Planning – FAST Diagram



The chart below, Figure 4, shows the priorities for each of the workshop groups as well as the arithmetic mean for all participants. Clearly, the participants felt that Caltrans Transportation Planning should be focusing on functions related to recommending strategies and solutions as well as prioritizing projects. In contrast, the majority felt that the various administrative functions related to reimbursing work, ensuring compliance, and mitigating impacts were not as important.



**Figure 4 – Prioritization of Planning Functions**

Provided below are some of the comments captured during the paired comparisons. These help provide insight into the thinking of the participants in thinking about the importance of planning functions.

*Recommend Strategies vs. Align Strategies*

- Caltrans is supposed to be the experts at recommending strategies. If we don't, who will?
- We lack the clout to recommend strategies - better to focus on aligning them.
- Recommending strategies infers leadership and taking a proactive role in planning whereas aligning strategies is more about ensuring that plans are consistent with policies.

- Planning needs to ensure that all divisions / stakeholders are aligned to ensure cohesiveness and consistency because the role of planning is about taking a "big picture" outlook.
- Aligning strategies is more about communication and consensus building. This is an important role for Caltrans Planning.
- It is better that everyone in a region agree rather than follow an entrenched position.

#### *Recommend Strategies vs. Recommend Solutions*

- Viable solutions provide a way to realize the strategies - more concrete.
- Planning's focus should be at a higher level (plans vs. more prescriptive solutions).
- Solutions are very important, however, they should be informed by strategies (i.e., plans).
- Solutions respond more to ways of implementing strategies (from an engineer's perspective).
- Strategies need real world solutions to realize them - they are harder to create therefore more emphasis should be placed on the solutions.
- Planners are about identifying strategies, which precede solutions. Strategies frame solutions.
- Solutions are more important than strategies because so many other entities are developing strategies. Emphasis should be on implementing the strategies rather than on planning.
- Caltrans needs to establish its own strategies independently in order to develop a compromise solution with other stakeholders.

#### *Align Strategies vs. Recommend Solutions*

- Focus needs to be on solutions and building consensus around the right solutions.

#### *Recommend Strategies vs. Ensure Compliance*

- The focus should be on ensuring compliance to maintain funding and resource levels from headquarters.
- The choice here is between idealism vs. pragmatism.
- The focus should be on making sure others are following through with policies and regulations so that strategies and solutions are realized.
- Focus on compliance thwarts risk taking and innovation.
- They are both pretty important - you have to ensure compliance with strategies or they are irrelevant.
- Strategies are the fundamental force behind our positions and decisions.
- Important to explain and ensure compliance of the strategies of the department and key stakeholders.

### *Align Strategies vs. Prioritize Projects*

- Better to make sure we do the right thing (at a bigger level) than just prioritizing projects.
- Good plans are easier conceived than acted upon - prioritization is about executing the plans effectively.

### *Recommend Solutions vs. Prioritize Projects*

- Reality is that Caltrans is no longer the driving force so we need to drive the priorities rather than develop the solutions.
- Emphasis should be on developing good solutions - prioritization is more politically driven.

The function analysis performed during the workshops will be instrumental in focusing the group in the forthcoming VA Study in identifying alternative concepts that will improve the value of Caltrans Transportation Planning. Further, the function prioritization exercise provides clarity and direction on which functions are most important and why.

### **Function-Based Thinking Leads to Potential Solutions**

As stated previously, the intent of the initial workshops was to focus on developing a clearer understanding of the existing program, including its functions and challenges. The application of function analysis led to one potential solution before subsequent VA study was even initiated.

As stated previously in this paper, one of the major challenges facing DOTP is addressing the transportation planning needs of a geographically diverse state like California. The various districts have different needs and yet have been provided with one set of planning products that do not always provide the optimal means of addressing these needs. One area where this manifests itself is in how DOTP personnel charge their time. Time accounting is essential in order to effectively manage resources and to develop a clear and accurate picture of how personnel are assigned at both the district and state level in meeting the internal and external transportation planning needs of California.

The functional thinking applied in the workshops led to a potential solution to identify an effective Work Breakdown Structure (WBS) and accounting system for DOTP. To determine the best solution, performance expectations need to be set and agreed upon to guide the development, implementation and evaluation of the system. The following criteria are proposed for consideration:

*Comprehensive – The system needs to meet the organizational characteristics and demands of each program and district. The organizational variances are requisite to serve the vast and diverse state of California. Developing standards that fail to accommodate these differences will degrade the accuracy of pricing activities.*

*Logical – To facilitate correct staff charges, the system needs to be easily understood. Employees need to be able to align their work with charging codes without having to reference code manuals after an initial overview of the system.*

*Compatible – The system must conform to Caltrans’ staff central time reporting platform. Designing the system to be compatible with staff central and the prominent WBS coding procedures for Capital Outlay Support (COS) will expedite the implementation and aid the comprehension of users, especially those familiar with COS charging practices.*

*Adaptable/Scalable – Change is the universal constant, DOTP needs the ability to adapt and continuously seek out opportunities improvement to improve products and services. The WBS system needs to be designed for durability and to easily accommodate expansion, lessening the need for system revisions when inevitable changes occur.*

*Credible – The system accurately monitors DOTP’s resources, facilitates oversight and allows for meaningful measurement of performance.*

The existing time charging system is designed primarily to support the WBS developed for project delivery (COS). Currently, the DOTP program categories referenced above fall under the accounting code of “40.00” and are each assigned a project identification number (formerly titled the “expenditure authorization” number). In Figure 5 below, the project number is used to charge time to “Community Planning” activities. The “N” under the “Phase” column indicates that the activity is not related to a discreet COS project. The “Reporting Code” is optional and used to identify work associated with a short-term or one-time activity such as a training course, or consultant task order. The “Sub Object” code indicates the role of the employee chart (“002” is supervision). The “Activity” and “Sub Activity” codes relate to the WBS levels developed for COS activities and are not currently used for 40 Program activities.



Project	Phase	Reporting Code	Sub Object	Activity	Sub Activity
0000001487	N		002		

**Figure 5 – Existing Charging System**

This proposal recommends retaining the existing Project Numbers assigned to DOTP and using the “Reporting Code” field to identify DOTP deliverables such as Transportation Concept Reports (TCRs) and Grant Administration. This allows the creation of codes that alphabetically reference the document or activity with abbreviations. Reporting codes also allow greater flexibility in that it’s easier to add or delete codes in the accounting system. This proposal also recommends taking advantage of additional coding fields to increase awareness and accountability for the work being performed.

The initial VA analysis of the DOTP program identified the functions of key deliverables. The basic functions of almost all planning activities relates back to three core actions that identify:

- *Strategies – developed from an initial scan to identify deficiencies, constraints and opportunities*

- *Solutions* – developed by a more refined comparative analysis of potential solutions
- *Projects* – alternatives developed by a robust analysis of strategies and competing priorities

The identification of strategies, solutions, and projects involves the same functions at increasing levels of detail and complexity. New “Activity” numeric codes in staff central could be created to identify basic planning functions such as:

- Collect data
- Analyze data
- Report data
- Disseminate data

The “Sub Activity” numeric codes identify the method to deploy the basic function. For example, what data was collected? The sub activity would answer that question with codes linked to obtaining:

- Vehicle or occupancy counts
- Safety performance indicators
- Environmental indicators
- Land Use indicators

Project	Phase	Reporting Code	Sub Object	Activity	Sub Activity
0000001487	N	40CP122	002	904	9010
↑ <i>Community Planning*</i>	↑ <i>“N” Not a COS Project*</i>	↑ <i>City of SD General Plan</i>	↑ <i>Supervision*</i>	↑ <i>Collect Data</i>	↑ <i>Land Use Indicators</i>

**Figure 7 – Proposed Function-Based WBS**

The resulting DOTP reporting system would look like Figure 7 above. The asterisk indicates the existing data field in staff central and the other codes are a “mock up” example to illustrate this proposal.

The merit of this system is that it satisfies all the anticipated performance objectives. The functional descriptions and purposes are relatable to a broad audience and it provides for comprehensive tracking of tasks and task durations. Since many of the activities and sub activities are germane to many planning deliverables they can be used for all 40 Program categories and deliverables captured under the reporting codes, thus simplifying and keeping the number of codes at a manageable level. The reporting codes can be customized to suit the need for each planning program and district and are easily adaptable.

The second phase of the VA study could be devoted identifying the functionally derived Activity and Sub Activity codes and the creation of an initial inventory of Reporting Codes and corresponding naming conventions aligned with DOTP's discreet deliverables and services.

## **Conclusions**

Performing VA studies at a programmatic level is a daunting prospect given the propensity of the size and complexity of such entities. Function analysis is an essential tool in cutting through the seemingly overwhelming complexity of large programs by shifting thinking away from discrete activities to the underlying functions. Doing this allows the participants and stakeholders to make critical connections between what they do as compared to why they do it. In the case study provided, function analysis forced the participants to develop a deeper understanding of DOTP and challenge many of the underlying assumptions and question both the need and practicality of the current ways of delivering critical functions.

Another important benefit of the development of a programmatic FAST diagram of DOTP is that it provided an expedient means of placing the functions that it delivers within a larger context of Caltrans as a whole and provides a means of communicating to others what DOTP does and how it supports the broader mission of improving mobility statewide.

Further, the potential solutions identified herein directly speak to the knowledge gained as a direct result of the application of function analysis and FAST.

Function Analysis applied to an overall program can be an important tool to lay the foundation for developing a strategic plan to start and new business venture or to re-engineer an existing organization or business.