Lessons Learned from ASCT and Systems Engineering

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Opening Up

- Technology Deployment Life Cycle
 - Research
 - Technology Development
 - People (Risk Tolerance)
 - Implementation
- Systematic Process

Credit: Regenold M, CTR Iowa State University

Context

- Federal Reauthorizations (1991 – 2012) Funding Eligibility for operations and maintenance Expanding.
- Rule 940 (ITS Architecture / Systems Engineering)
- Influence of Metropolitan Planning Organizations Growing
- Traffic Signal Programs Lack Resources

Complex Environment

- Freeway
- Arterials
- Land Use
- Peds
- Vehicles
- Bikes
- Transit
- Freight

Project Development / Funding Process Not Well Understood

Conceptual Framework (G.O.S.T)

Research Focus

- Freeway
- **Arterials**
- Land Use
- Peds
- **Vehicles**
- Bikes
- Transit
- Freight

Research Problem

- Variability in traffic demand reduces the effectiveness of static signal timing plans.
 - More TOD Plans,
 - Delay Optimization,
 - Fine Tuning
- A process is needed to match signal timing plans to traffic patterns to improve efficiency.
 - Traffic Responsive
- Transition time between plans reduces effectiveness
 - Minimize Transition Time

Are We Working on the Right Problem?

GIVEN : Signal Timing Plans
(Cycle, Split, Offset) are not
keeping pace with variability in
demand.

Strategy

Capabilities put in place
to achieve the Objective

Tactic

Specific methods to
achieve the Strategy

Adaptive Signal Control - Research

- ASC introduced in late 80s
 - Split, Cycle, Offset, Optimization, Technique (SCOOT)
 - Sydney Coordinated Adaptive Traffic System (SCATS)
 - Optimized Policies for Adaptive Control (OPAC)
 - Real-Time Traffic Adaptive Control System (RT-TRACS)
 - Real Time Hierarchal Optimized Distributed and Effective System (RHODES)

Field Demonstration Test

- Significant reductions in Delay, Fuel Consumption & Emissions
- Requires non-standard local control
- Algorithms are complex
- Extensive detection requirements
- Robust communications
- Expensive to Implement, Operate and Maintain
- Requires active monitoring and calibration

Shifting to Technology Deployment

Problem Statement

- Reduce Complexity
- Minimize Detection
- Low Bandwidth Communication
- Utilize Existing Control

ACS-LITE

Features

- NTCIP
- Econolite / Peek / Siemens / McCain
- Low Bandwidth Communication
- Existing Detection
- Spilt and Offset Tuning

People

Deployment 1991 - 2005

- Research
- Field Operational Test
 - Conditions match functional objectives
- No Systems Engineering
- Evaluations
- Organizational issues not considered
 - Skilled Staff
- Procurement – Sole Source

Technology 2006 - 2009

- FHWA Active Promotion of ACS-Lite
 - Econolite
 - Siemens
 - Peek
 - McCain
 - Naztec
 - NW Signal
- New Products
 - InSync / SynchroGreen / QuicTrac.....
- Other Systems Under Development
- Less than 1% of all signals equipped with ASCT
- Traffic Responsive is Ubiquitous

Every Day Counts Initiative 2010 - 2012

Goal: Mainstream the use of ASCT.

Barriers:

- *Uncertainty about benefits,*
- *Cost,*
- *Complexity*
- *Clear understanding of operation and maintenance requirements*

Implementation Approach

Mission: Provide tools to address risk, characterize ASCT as a strategy to improve operations.

Objective 1: ASCT/Tools will be used by 40 agencies to guide planning and implementation.

Objective 2: Develop Performance Measures, data needs and methodology to support evaluation of ASCT.

Systems Engineering Process

- Systems Engineering Guidebook

Systems Engineering Process

WWII Analogy - Eisenhower

- How fast Germans moved armies during WWII
- America embroiled in the Red Scare
- Post war prosperity presented an opportunity

How would we use a new roadway network

- Move armies quickly
- Move people, goods & services efficiently

What slows armies down?

NEEDS

- Intersections
- Narrow roads
- Tight curves
- Incomplete network

High Level Requirements

- Limited access
- Wide lanes with shoulders
- Divided highway
- High design speed
- Comprehensive network

Detailed Requirements

- The highway shall have no at-grade crossings.
- The highway shall separate the two directions of travel.
- The highway shall accommodate vehicles traveling at 70 mph.
- The highway shall have 12' foot lanes.
- The highway shall have vertical clearance of 16.5'.
- The highway shall have maximum grade of 6%.
- The highway network should comprise principal east-west and north-south routes.

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- Did Eisenhower know anything about building roads?
 - Do road builders know anything about moving armies?
 - Do they need to?

Did the road get built right?

Did we build the right roads?

Systems Engineering

Mitigating Risk

- Designing the roads incorrectly
- Designing the wrong roads
- Spending too much
- Taking too long to build
- Responding to challenges

Purpose of SE Model Documents

- Evaluate need for Adaptive Control
- Limitations of Existing System
- Objectives & Needs for Improved System
- Requirements to guide procurement and acceptance testing
- Basis for validation testing

Model Document *Process*

Build Requirements

- Answer questions
 - About the situation
 - About you
- Select and tailor ConOps statements
- Select and tailor requirements

Evaluate Alternatives

- Evaluate proposed approaches/products against requirements
- Solution feasible given constraints?

Continue Tailoring Until Solutions...

- Fulfill requirements
- Are feasible

US Implementation 2015

Application of Systems Engineering Before and After MSED

Systems Engineering at all Phases

- Research
- Technology
- People
- Implementation
- Clarifies the Goals and Objectives
- Identifies Performance Measures
- Provides Context for Constraints
- Address Risks
- Conforms to Federal Regulation
- Competitive Procurement
- Manages Cost

Application to Automated Traffic Signal Performance Measures

- Systems Engineering is GIVEN
 - Goals, Objectives (NEEDS)
 - Validate research outcomes
 - Fuels Innovation
 - Requirements
 - Address risks
 - Support acceptance testing
- Leverage funding opportunities
 - Ped/Bike
 - Transit
 - Connected Vehicles, Integrated Corridor
- Collaboration and Competition help the process
- Don't hide failures

Good Basic Service (GBS) Model

Leg Segments and Composition

Summary

- Organizational and Institutional Issues must be acknowledged
- A Systematic process is critical to linking Research to Implementation and can drive innovation
- Innovators and Early Adopters must be leveraged to demonstrate benefits
- The majority of the market is risks averse
- Meaningful Performance Measurement
- Top Down & Bottom Up approaches are key

Every Day Counts 4

- Request For Information (RFI)
 - Federal Register Notice
 - Innovation of Interest
 - Automated Traffic Signal Performance Measurement System
- Submit responses by email to everydaycounts@dot.gov

Deadline: January 31, 2016

Questions?

Federal Highway Administration
RESOURCE CENTER

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