Title: Management of Traveling Motorists: Science, Art and Leadership

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Author(s): M. Alkadri and M. Coleman

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Abstract: Examined are the principles required in the field of traffic management which lead to improved effectiveness and productivity of the system manager. The major concepts evaluated in the report are, leadership, creativity, motivation, innovation and change. This report also examines how the traffic manager can apply the principles of engineering management to creatively institute a change, influence the driver's behavior and automobile use, and effectively get drivers to participate in the initiation and implementation of significant traffic management projects.

MANAGEMENT OF TRAVELING MOTORISTS

M.Y. Alkadri and M. Coleman

EMP - P8911

Management of Traveling Motorists
Science, Art, and Leadership

By: AlKadri, M. & Colman, M.

EMGT-541, Engineering Management Concepts and Principles
Supervision: Prof. D. F. Kocaoglu

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TABLE OF CONTENTS

LIST OF EXHIBITS

LIST OF FIGURES

Introduction and Executive Summary

I. The Problem:

The traffic engineer is the technical manager in charge of running a traffic system in a manner that is:

1. consistent with the established rules and policies, and
2. spirited by innovation, creativity, and engineering judgment, and,
3. sensitive to the public sentiment and the motorists' needs and aware of their limitations. Often, traffic engineers move from technical design areas into traffic management positions with limited background in engineering management and little experience in managing motorists -the external constituency of the traffic manager. Therefore, the above goal is sometimes missed resulting in a threat to the function and the structure of the traffic system.

II. The Project Objectives:

The objective of this research project is twofold:

Fold A. Examine how the traffic engineer (the traffic manager) can apply the principles of engineering management to:

1. Creatively institute change, and ***influence the driver's behavior and automobile use***, and
2. Effectively get the external constituency to ***participate in the initiation and implementation of significant traffic management projects.***

Fold B. Since traffic management has its own unique experiences in dealing with an "external" constituency, the project will also ***highlight these experiences which may be helpful to engineering managers in other engineering disciplines.***

III. The Research Method:

The strategy of this project is to have a broad, macroscopic review of some critical issues involved in understanding, communicating with, and getting feedback from the external constituency -the motorists- to achieve better management of the traffic system. Subsequent microscopic research will be needed (at later dates) to study the vertical depth of many of these issues.

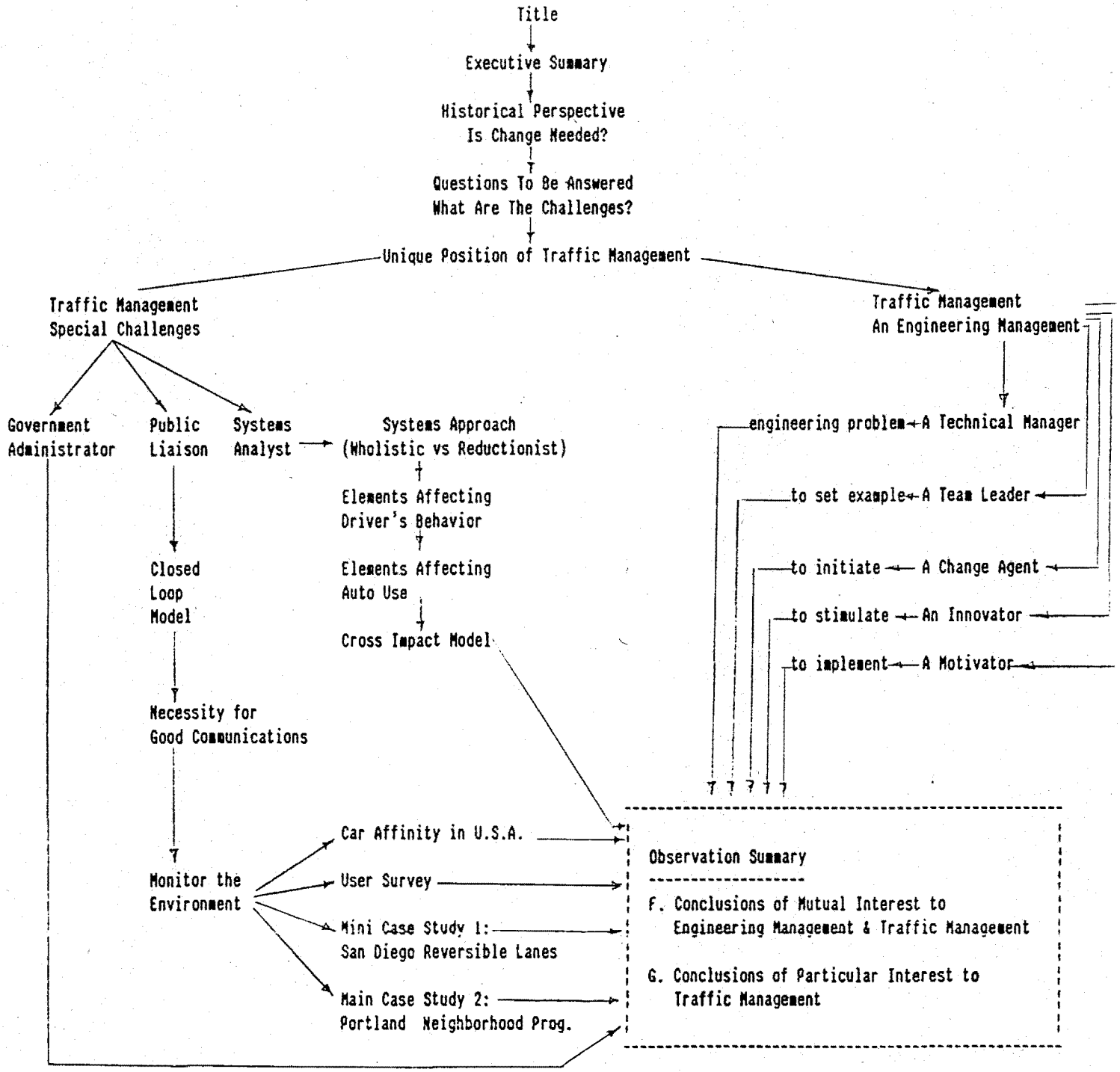
Within the above proposed context, the project introduced a set of questions to identify significant management issues that every traffic engineer has to deal with once he/she assumes a traffic management position. The project then searched for answers through the literature, a survey, one minor case study, and one major case study.

Note:

Throughout the project, the word "traffic manager" indicates "traffic system engineer", who is in command of the operation of the traffic system and its elements -including the road user and his automobile.

IV. Project Findings/Research Conclusions:

Detailed elaboration on the observations was made along each step of the study. The final research findings were aggregated in the Checklist of Project Conclusions.



- Research Paper Flowchart -

A. Historic Perspective

A.1. An Ancient Problem:

Traffic problems and the necessity for traffic management are not new. Rome and Baghdad, two of the largest cities of their times, had suffered from cart, horse, and pedestrian congestion. Carcopino [9] described the state of traffic congestion in Rome and the measures taken to control it:

{The great dictator Julius Caesar realized that in alleyways so steep, so narrow, and so traffic ridden, the circulation by day of vehicles serving the needs of the population of so many hundreds of thousands caused an immediate congestion and constituted a permanent danger. He therefore proclaimed a radical and decisive step: From sunrise until nearly dusk, no transport cart was henceforth to be allowed within the precincts. Those which had entered during the night and had been overtaken by the dawn must halt and stand empty...no daytime traffic was allowed in ancient Rome except for pedestrians, horsemen, litters and carrying chairs [to carry people unable or unwilling to walk].}

A.2. The Century of the Road and Automobile:

During the early 1900's, cars were welcomed as "healthy" alternatives to the common mode of transport of that time -the horse. According to Ritchie [9], the "Surgeon General of the United States in his annual report welcomed the automobile as a major contributor to health by eliminating that favored resort and breeding ground of disease-bearing flies -horse droppings."

Highways were also in some respect considered land conservation tools. According to Ritchie, "...it was estimated that New York, to sustain the standards of city life at that time [early 1900's], needed 130,000 horses. And to provide their food, these horses needed over 100,000 hectares of land. Compare this with 3,600 hectares for a super-highway from New York to Washington."

The culture and the attitudes regarding automobiles did not change throughout the century. Cars were a cherished possession. During the late fifties, the sixties, and the early seventies, cars continued to get bigger, fancier, consumed more fuel, and cost less money. Freeway construction seemed endless and the dollars to pay for it seemed limitless. Freeway control was unnecessary and traffic management was less challenging.

Smog and pollution had not yet become national worries. In 1972, A. O. Kerensky [9], then president of the Institute of Highway Engineers said:

"The danger lies in exaggerating the mechanical shortcomings, such as congestion, pollution, and noise, and underestimating the spiritual values of accessibility, independence, and reduction in frustration."

A.3. The New Realities:

In the late 1970's and throughout the 1980's, new realities had surfaced. Many freeway systems reached saturation levels for the first time. Federal dollars for freeway construction began to shrink. Los Angeles smog became a major health concern in Southern California. Global warming (due to excessive carbon dioxide in the atmosphere) has reached alarming levels. The State of California awakened and introduced new strict smog-control laws and regulations. Yesterday's wealth, space, and abundance do not exist today. The traffic problems and challenges of the 80's needed new thinking and new strategies. The bible of the transportation industry, the 1965 *Highway Capacity Manual* was thoroughly re-written in 1985, and is still being appended and modified. Fundamental transportation/traffic engineering practices are being re-evaluated.

The need for evolution in traffic management is growing. The dynamic nature of traffic systems constantly demands creativity and innovation. The sociotechnical nature of transportation problems requires technical excellence as well as management leadership on the part of the transportation engineer.

B. Questions to Be Answered:

In light of these ever increasing challenges, what is the role of the traffic management? How can traffic management learn from the principles of engineering management? Conversely, can engineering management learn from the experiences of traffic management? Is there more room for invention or for innovation in the field of transportation/traffic management? Do traffic controllers create technological "pushes" or respond to "market pulls"?

Who is our constituency? What is the relationship between the traffic engineer and the traveling public? Can that relationship be improved? How deeply-rooted is car affinity in the American society? Does it matter? Is it justifiable? Is it dangerous? should it change?

What influences the driver's behavior? What influences automobile use? Can we *ever* change people's minds (including ours) about carpooling? Mass transit? Love for our cars? How much intervention will the motorist tolerate? What is feasible and what is acceptable in managing the motorists?

We recognize that books could be written about each of these subjects, but our purpose here is to identify issues that each traffic engineer in a management position has to prepared for while dealing with his external constituency. As stated in the introduction, this exploratory horizontal approach can be complemented by a series of vertical studies to examine each problem in depth.

C. The Unique Position of Traffic Management:

Traffic engineer has a dichotomous management function: managing his internal technical constituency (subordinates) and, managing his external non-technical, non-subordinate constituency -the traveling motorists.

D.1. Traffic Manager: A Technical Manager

The traffic manager is a technical manager because of the nature of his work. Shannon [10] highlighted some attributes that distinguish technical and engineering managers from other managers. The first attribute is that the technical and/or engineering manager is concerned with the *technical function.* "Technical function is oriented to innovation and change." Innovation and change are indispensable tools for handling growth and complexity of the traffic system.

The technical function deals with "dynamic and flexible planning philosophy." [10] Traffic systems are fluid, unpredictable, nasty, and hostile; and thus, need continuous assessment and flexible planning.

"Most technical functions do not directly bring about increased sales or reduced costs." [10]. Traffic engineering/ management functions do not bring direct profits either. Successful implementation of a transportation/traffic project may result in reduced costs, however, which could be considered indirect gains.

In the technical process, "the outcome of individual projects and programs is highly unpredictable and involve risks", says Shannon. Traffic systems involve the human element -the most unpredictable of all. Uncertainty is embedded in every transportation project and traffic management program.

"The outcome of individual [technical] projects", says Shannon, occurs with lags of months or years, during which period, some of the factors that entered in the initial project selection decision may change significantly." Frequently,traffic and transportation projects take years to plan and years to materialize. Future trends can only be guessed at the time of the initial planning. Many variables (demographics, civil growth, land use, economic status and so forth) may change significantly at the time of completion.

Finally, just like any other technical manager, traffic engineer (traffic manager) has to face the four principle types of technical function uncertainty. He has to face:

a) The threat uncertainty, which is inherent in the physical and performance characteristics of the traffic system.

b) The technical uncertainties which bring the challenge of experimenting with newly created problems and newly created technologies.

c) Internal program uncertainties which have to do with engineering reliability, costs, schedules, and so forth.

d) The external uncertainties represented by availability of funds, relations with other organizations and government agencies, and acceptability of the project by the public.

D.2. Traffic Manager: A Team Leader

Also according to Shannon, the technical manager "serves predominently as a planner, facilitator, and communicator." Haven [5] described the multiple role of the traffic engineer as leader, liaison, dissiminator, spokesperson, change agent, disturbance handler, negociator, and resource allocator:

{Another key item in the development of a system such as the HOV lanes, is the evolution of the project development team. The traffic engineer is a continuous link through the entire project. Creative ideas are best initiated by traffic engineers dealing with day to day situations out in the field. Then the ideas must be enveloped into the planning process (the traffic engineer becomes a salesman). The specific project then evolves with input from planners, the public, legislators, transportation engineers, systems analysts, electrical engineers, environmentalists, enforcement and emergency agencies (the traffic engineer becomes a team leader). When the project goes into design and construction, a team of engineers (including the traffic engineers) must be developed to consult with the designers and field construction crews, to provide oversight and to design *systems* details with the thoughts of long term operation in mind. As construction nears completion, this group evolve into an *operations* team which handles training of a variety of people, day to day operations, system maintenance (hardware and software), and continued system development. This is a significant effort which requires competent specialists and equipment. The system does not operate without people [internal] and equipment no matter how automated it may be... the project leader's job becomes that of a supporter. He must alleviate the blows of budget cut backs in both areas, (people and equipment), negotiate for things his people need, and provide encouragement for the people who are doing the job.}

D.3. Traffic Manager: A Change Agent

Leadership is required to set examples to encourage change in the outside world. The traffic manager has to take the initiative. To set good examples, innovative solutions have to be introduced. Caltrans, for example, Caltrans exemplified leadership by initiating the Transportation Management Action Plan for rideshare alternatives, a package of incentives to reduce auto use. Exhibit [1] is an outline for that Plan. Caltrans tried the Plan within the organization and championed its introduction to the rest of the State employment agencies via the Governor's Office. The next challenge for Caltrans is to devise similar stimulating proposals and introduce them to the private industry.

D.4. Traffic Manager: An Innovator

Traffic engineering is a well-developed technology. It is at the upper part of the "S" shape (see Exhibit [2]). "Breakthroughs" have become much less frequent. A revolution in traffic engineering will not occur until a revolution in the man's modes of transport has occurred. Alternatives for today's problems are more innovation -not invention. Old ideas (like ridesharing and carpooling) could perhaps be "re-packaged" to make them more attractive to the motorists.

D.5. Traffic Manager: A Motivator

The traffic engineer must understand the motorists attitude and their consequent behavior. Once the traffic system manager realizes the needs and interests of his constituency, he can devise an appropriate set of incentives to influence their behavior and gain their satisfaction.

a) Motorist Attitude:

The most common motorist philosophy is that which preserves self-interest, and seeks advantage. Some of the common motorist attitudes may be "God bless me, and to hell with you.", "I love my car. I hate yours", "Get out of my way", and "move it". The project survey, somewhat more moderately, reflected many of these

State of California — Business, Transportation and Housing Agency

Memorandum

To : Caltrans Employees

Date : August 3, 1989

File No.:

From : **DEPARTMENT OF TRANSPORTATION** **District 11**

Subject : **Rideshare Alternatives & Incentives**

Governor George Duekmajian's Executive Order D-73-88 requires State Agencies to implement a Transportation Management Action Plan. The primary objective is to achieve a 10% reduction in state employee commute trips during peak hours. Caltrans District 11 has in place the following Transportation Alternatives and Incentives to achieve the Governor's Executive Order goal:

o **Vanpool:** Caltrans vanpool from El Cajon area to Old Town. Cost: approximately $20.00 a month. For information, call Dick Saliba, ext. 7665, or Kevin Stevens, ext. 6692.

o **Vanpool Driver Payment Program:** Dist. 11 employees who become the primary driver of a vanpool can receive $50.00 a month under this program.

o **State Vehicle Carpools:** State cars are available for three or more state employee riders. Cost: $38.00 - $43.00 a month, depending on the distance traveled and the number of passengers. Contact Manuel Demetre at ext. 7665 for further information, or ask your supervisor.

o **Flextime:** In certain situations, employees are allowed to alter work times. On July 1, 1989, I expanded the use of Alternative Work Schedules to include the 9/80 Work Schedule. Supervisors have latitude to approve the 9/80 Work Schedule providing that employees regularly commute by vanpool, carpool, transit, bicycle, or walk, or start work at 6:45 AM or earlier, or leave work at 6:00 PM or later. For more information, ask your supervisor.

o **Preferential Parking:** At the District Office, reserved parking spaces are assigned to carpools of two or more persons.

o **Bicycle Lockers:** Free use of bicycle storage lockers, clothes lockers, and showers for bicycle commuters is available on request.

o **Ridesharing Matching Services:** Computer matching services are available on request. Dial 237-POOL or ext. 7665.

o **Discount Transit/Trolley Passes:** A discount of $15.00 on the purchase of monthly trolley and transit passes is available to Dist. 11 employees. For more information, contact Denise LeClair, Old Town Rideshare Coordinator, ext. 7665; Pat Basimakopulas, Rideshare Coordinator, Chula Vista Complex, ext. 6433; or Dorothy Reitz, Rideshare Coordinator, Kearny Mesa Complex, ext. 6860. For your convenience, bus and trolley schedules are located at all three facilities.

Additional incentives to ridesharing are lower insurance premiums, reduced commuting costs, extended live of the personal vehicle, cleaner air, and a more relaxed and enjoyable ride.

I encourage employees to use one of more of these available alternatives.

Jesus M. Garcia
District Director

Exhibit 1

State of California Transportation Action Plan

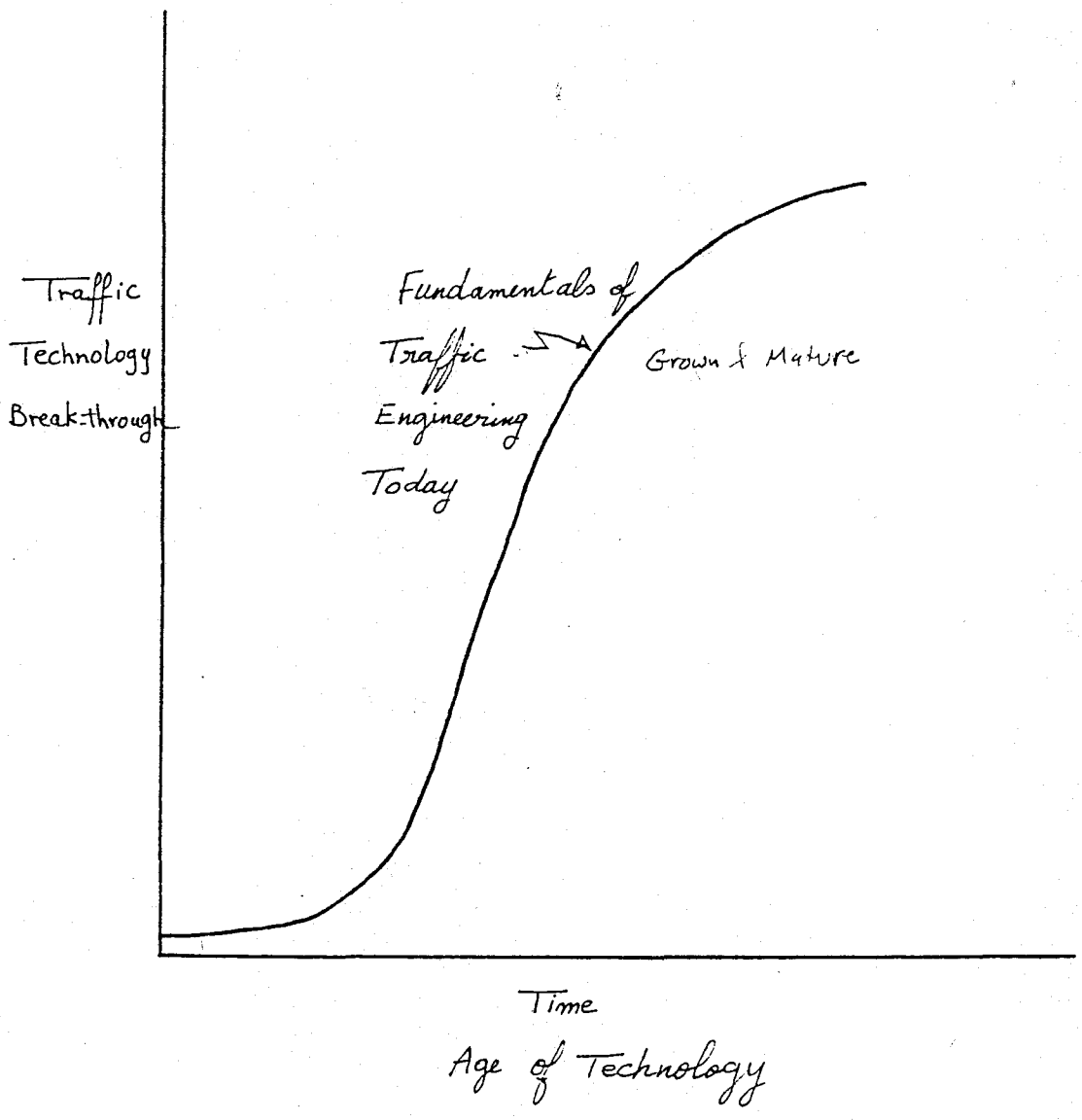


EXHIBIT 2

S_SHAPED CURVE of

"INVENTION" LIFE_CYCLE

attitudes. Survey respondent # 58 (male:34) stated that: "U.S. Hwy 26 is awful, even dangerous. It is literally every man for himself, & only the strong survive."

b) Motorist Behavior:

A person's behavior as a motorist tends to be less congenial than his normal behavior otherwise. Once we sit behind the wheel, the an adversary instinct is activated. A more "militant" mentality seems to get the command. Survey respondent # 61 (male:30) said: "Ramp lights sure beat sitting behind an old lady at the end of the ramp w/o any way to accelerate onto the hwy & into the traffic flow." This same person may open the door for that same lady and let her first while walking into a building for example.

c) Only one of Maslow's [10] secondary motives, Safety, applies to motivating motorists. Physiological, social, ego, and self-fulfillment motives are irrelevant. The only applicable motivators are those which reduce the *perceived burden* on the motorist. Motives of this nature nay be surviavability motives, comfort, convenience, time saving, money saving motives, work-at-home motives, and flexible work hours motives.

E. Unique Challenges for the Traffic Manager:

The traffic engineer who is in a traffic management position faces additional problems his peers in other engineering disciplines do not normally face.

E.1. Traffic Manager: A Government Administrator:

Several important facts which add to the difficulty of the traffic manager's job are related to the status of his/her conventional employer: the government (city, county, state, or federal government). This is also true worldwide where traffic management is a government function. Some of theses special problems were outlined by Shannon [10].

E.1.a. Public works have standard measures that are less rigid, less specific, and thus more difficult to measure and control.

E.1.b. Public projects are aimed at public welfare and are less concerned with profitability. This makes considerations of cost/benefit harder to define. One author of this paper (Alkadri) ran into this dilemma while he was introducing a new discrete system modeling and simulation package in the summer of 1989 to the decision makers in the California Department of Transportation (Caltrans). The question was asked: "How will Caltrans *benefit* from this package? What is our *gain*?" It was particularly challenging to convince the audience with the worthiness of that project since it could not be defined in terms of direct increased sales or reduction in material costs. It was only oriented toward increased system performance to serve the *public welfare.*

E.1.c. Profit motive is generally lacking and so is the spur of competition. There are no material product to sell, only services that no one else provides.

E.1.d. Performance evaluation of public projects/program is difficult. Like the argument in 1.b., public interest and public welfare are hard to define. Public safety also has controversial measures. For example, how many fatalities/year are considered "acceptable"?

E.1.e. In private engineering industry, decisions to plan, design, manufacture, and distribute products are made internally. In traffic industry, the traffic organization has to deal with external forces -the legislator- to approve policies and get funds.

The dual role of technical professional and government administrator is also discussed in government administration literature. Carl J. Friedrich, a renouned contributor to the public administration field, described a dual standard by which the traffic manager's work must be evaluated:

"...a modern administrator is in many cases dealing with problems so novel and complex that they call for the highest creative ability. This need for creative solutions effectively focuses attention upon the need for action. The pious formulas about the will of the people are all very well, but when it comes to these issues of social maladjustment the popular will has little content, except the desire to see such maladjustments removed. A solution which fails in this regard, or which causes new and perhaps greater maladjustments, is bad; we have a right to call such policy irresponsible if it can be shown that it was adopted without proper regard for existing preferences in the community, and more particularly its prevailing majority. Consequently, the responsible administrator is one who is responsive to these two dominant factors: technical knowledge, and popular sentiment."(1)

This dual standard applies to the traffic engineer charged with "administering" a goverment's transportation policies. According to Friedrich, a truly responsible traffic engineer strives for more than technical excellence when addressing "maladjustments" in the transportation system. He also strives for popular support and willing compliance with his "creative" and innovative solutions to "novel and complex" traffic problems.

E.2. Traffic Manager: A Public Communicator & Liaison:

The relationship between the traffic engineer (manager) and the traveling public is often a one-way relationship. Although the motorists are his external constituency to manage, they are also his customers, the recipients of the outgoing products and services of his projects. This creates a "closed-loop" relationship model as shown in Exhibit [3] below.

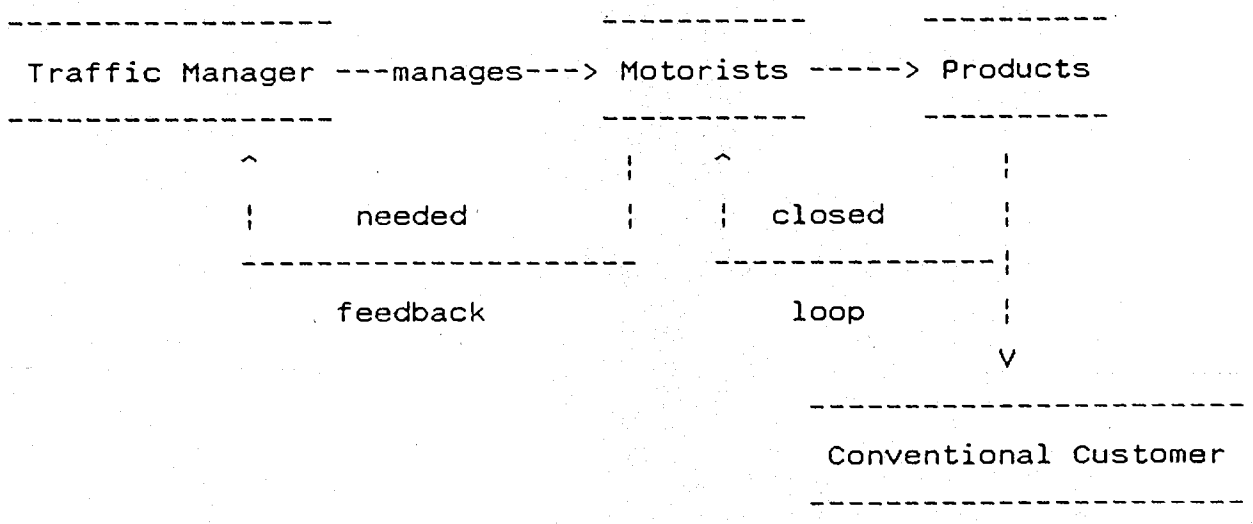


Exhibit [3]

Closed Loop Product & Needed Feedback Model

Normally, the traffic manager does not have direct contact, personal familiarity, or one-to-one communication with his external constituency. Typical one-way communications are in form of regulatory and advisory roadside signs (stationary, mobile, and electronic changeable displays), traffic signals, public announcements, TV and radio station traffic reports. Public complaints (telephone calls, letters etc.) and citizen committees sometimes provide the reverse communication (public feedback).

E.2.1. Monitoring the Environment:

Public sentiment is our form of market pull. According to Shannon [10], "Contrary to the common believes, recent research indicates that the largest percentage of successful projects result from demand pull [not technology push]." Assuming this is true, traffic management needs to "monitor the environment" and "test the market" more frequently.

To monitor the environment, the traffic engineer need to monitor growing trends (the duration, speed, and persistence of trends), impact of change, demographic changes, and the developing societal needs and certain cultural values and how they affect his job.

The automobile is a prime component of the traffic system. An indispensable part of "monitoring the environment" is to understand the status of the automobile in the culture of the society.

Surveys are a common means for market testing and staying ahead in private industry. In the case of traffic management, they are among the best tools for providing the often missing feedback link from motorists to the traffic management. Public meetings and citizen committees are good forums for live discussion, but they reveal the sentiment and interest of the attendants only. Surveys on the other hand reach a larger percentage of the population. They simulate one-to-one contact with a broader range of participants. Written surveys are fair conveyors that let you hear from both the quite and the noisy giving them both equal "airtime" and equal input weight -which is difficult to do in public meetings. Intensive amount of focused information could be gathered in a short time. If surveys are well designed, they permit good scientific and statistical inference.

Due to the lack of competition in the field of traffic "services" however, traffic management is often complacent -and sometimes reluctant- to test the market (the motorists). To supplement our learning experience in this project, we decided to experiment with the market on our own. A limited freeway-user survey for Portland area was designed, distributed, collected, and analyzed. The survey results are discussed in the subsequent sections.

To examine how a transportation project gets initiated, how the public is brought aboard, and how the project is then implemented and evaluated for success or failure, we reviewed one major case study from Portland, Oregon: The Division Corridor Neighborhood Traffic Management Program (DCNTMP). We also briefly reviewed a minor case study from Southern California: High Occupancy Vehicle Reversible Lanes (HOVRL) in San Diego, California. Both the Portland case study and the San Diego example are discussed in the subsequent sections.

E.3.a. Automobile Affinity in America:

The heart and mind of traffic engineering is to deal with the automobile which Ritchie [9] defines as most "cherished domestic possession." The traffic engineer/manager ought to understand the unique love relationship which has developed over the years between man and the automobile.

The automobile is a loyal servant (excepts when it breaks down in the middle of the road). Throughout the centuries, the human race adored and loved the horse. In the age of steel and concrete, and advanced technology, automobiles are our obedient stalians. They are strong and powerful, loyal and beautiful. The automobile is a private mobile personal cocoon. In it, you can kiss your lover, talk to your wife, joke with the kids, listen to your favorite music, adjust the heat/air, eat, smoke, and even take a nap. In it, you can keep a map, a telephone book, and a first aid kit. You sit on your own "preserved" chair, drive your own way, be in control of your own moves: stop when you like, go when you please, and set your own pace.

Ann Taylor Fleming, a Los Angeles Times Writer, described the American passion for cars [3]:

{After all, this is why people say they leave here:
To escape the bumper-to-bumper, air-befouling, tension-causing freeways.
You can hardly call them freeways anymore.
Because they're seldom -if ever- free.
That **WAS** the idea:
High speed freedom of unparalleled, unhindered miles.
A daily automotive high.
Just get in your car, turn it on, tune in to your stereo,
And drop out.
That's ... the sensation of being free, Alone,
Incubated in your own little fast rolling world
With no one to bother you or hinder your thoughts
-Even if you are driving to the market to pick a quart of milk.

It is the ultimate "tune-out" time.
The sensory: A chollidoscopic back drop to your day dream.
It is the kind of time that you cannot duplicate on foot.
Because then you are frayed to immediate sensation,
Be it a cool wind,
A smell of a pizza,
Or the bark of a dog.
[All] sensory distractions!
In a car, there is none of that.
That's why we also resist any attempt to make us carpool.
The very word [carpool] sends shudders to the local soul.
Congering up a bunch of scrunched-together, hinge-faced,
pin-stripped commuters.
No!
That's definitely not us.
And -of course- cars are our personalized symbols-of-status.
From Jag's to the jeeps,
Cars telegraph our self-images to the passers-by.
A silent shout from lane to lane.
In that same LA Times poll, over 40% said that cars had ruined their city.
But did that mean that they would gladly give them up?
double up?
or, better yet, take a bus?
No Way!
83% said they hadn't been on a bus for over a year.
20% said they hadn't walked 4 city blocked for the past 12 months.
We just don't get it.
Or, we do get it, but we don't want to get it, if it means giving up our cars.
They are our pleasures
our passions
& our turtle shells.

E.2.b-A. Portland Survey on the Road User Perspective:

A 23-question user survey was designed to solicit people's thoughts on a variety of traffic issues. The main focus was ramp control and ramp meters (see questionnaire sample copy Exhibit 1). Such thoughts are major components of the *personal* perspective on the issue of managing motorists. If people (i.e., system users) are dissatisfied with the system or its operations, the system will be bound for trouble no matter how good it is technologically.

Ramp metering (the main issue of the questionnaire) is a part of freeway management system which is a sociotechnical system. The sociotechnical system involves interactions between technology, machine, and the human element. The human element involves human needs, human perceptions, human reactions and interactions, fairness issues, legislative matters, enforcement organizations and so forth. Therefore, the human element MUST be considered as a major element determining the success or failure of the system.

E.2.b-B. Purpose:

The principle goal of the survey is to provide feedback channel for system users to examine their needs and identify deficiencies in the system, as they are determined from their perspective. The survey may indeed locate major areas for improvements regarding ramp control and freeway operation. This questionnaire was designed for Portland, Oregon. A similar survey is being contemplated for San Diego freeway system. The Portland survey (145 questionnaires) will serve as a testing ground and as learning experience in preparation for the large-scale user survey (10,000 questionnaires) in San Diego. Once San Diego's survey is completed, Portland's survey will be compared with it to see if there are any common problems and whether one city can learn from the experience of the other.

Besides Professor Kocaoglu, three other professors from Portland State University were consulted about the ideas, contents, and the design of the questionnaire: Professor Harold Linstone, Professor Wayne Wakeland, and Professor Warren Harrison. Each contributed significantly with comments and suggestions. Professor Linstone still thinks that one-to-one interviews are much more effective and informative. Professor Wakeland gave some comments about the structure of the questionnaire. Professor Harrison approved of the idea and participated himself in filling out one copy. Due to time constraints, only five personal interviews were conducted with survey participants.

E.2.b-C. Sample Population & Distribution of Questionnaire:

One-hundred and fifty copies of questionnaire were made and one-hundred forty-five copies were actually distributed. One-hundred copies were distributed during spring 1989, The other forty-five were distributed during the fall 1989. The number of returned copies currently stands at sixty-eight. Hence, the rate of return is about 47 %.

The sample population was largely graduate, well educated, working people. The sample is not representative of the society as a whole but it is a good segment of the society to be tested first. The highest number of questionnaire copies was distributed on the Portland State University Campus to students, faculty and staff members. Participating students were mostly part-time graduate students who belong to the working category which uses the transportation system extensively. Other copies were filled up by people at places like First Interstate Bank, Kinko's Copies, and Battelle NW Inc. More copies are still expected to come from Target store in Beaverton, Fred Meyer store on Barbur Boulevard, Portland Metro District, and WareMart Food Store on SE Washington Street in Portland.

E.2.b-D. Analysis of Questionnaire:

The analysis of the survey is not elaborate. No rigorous statistical methods have been used. Statistical precision and confidence levels will be used for San Diego's survey. Some answers indicated confusion in understanding the questions. Based on the analysis of the 68 returned questionnaires, many corrections are now suggested for San Diego survey.

One common source of confusion was that people did not know whether a questions was related to the morning or the afternoon commute. The survey focused on the morning commute but it was not stated explicitly in the questionnaire. However, many people based their answers on the assumption that questions were related to the afternoon period -apparently because this is when those people experienced more problems. For Portland survey, it should have been left to the participant to determine which period he/she experienced problems with and choose to talk about. For San Diego survey, only the *morning* period in the direction of *heavy* traffic will be examined and must be clearly stated in the questionnaire.

Another common source of confusion was the use of the word "ramp" while the word "on-ramp" or "entrance ramp" should been used instead. Some answers indicated that drivers were having problems with off-ramps, which is irrelevant to ramp metering, but may have to do with the overall operation of the freeway at the ramp intersection itself. This confusion should be eliminated in San Diego survey.

For the purposes of our engineering management study, ten out of the twenty-three questions have been selected for analysis. Those are: questions 1,3,6,14,15,17,18,19,20, and 23. Question 2 was only partially analyzed to get the proportion of freeway usage. Question 23 was also analyzed to further describe the survey sample. The following is an exhibition of these questions, the purpose of each question, aggregation of the received answers, some selected comments, and the corrections needed for San Diego survey. The significance of the collected data will be examined in the subsequent sections.

Analysis of Freeway User Questionnaire

Note 1:
In some instances, the *mode* was used to approximate the average. Computations for the mean and standard deviation are deferred for the present time.

Q1: Do you have a car?
Purpose of Question: Determine car availability.
Analysis of Answers:

Number of people who answered the question = 68
Yes=64 rate=64/68 = 94 %
No= 4 rate= 4/44 = 6 %

Needed Corrections (for San Diego Survey):

- Eliminate the entire question since survey will be handed on the field to freeway users who, presumably, have cars.

Q2: Do you use the freeway for your daily commute?
(Partial analysis only)?
Purpose of Question: Determine proportion of freeway commute and infer rough estimate of car use.
Analysis of Answers:

Number of people who owned a car=64 (from Q1)
Number of people who owned a car, used the freeway at least twice a week, and whose trip purpose was work=53.
Appx. auto usage = 53/64 = 83 %

Note 2:
Questions 3,4,5,7, and 10 are to determine trip pattern and if people (especially short trip travelers) would avoid the freeway and choose to travel on city streets partially because of delays at the ramp meters.

Q3: What is usually the purpose of your trip?

Purpose of Question: Same as note 1.

Analysis of Answers:

Number of people who answered the question = 66

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              +-----------------------------------------------
Work          |************************************ 37/66 = 55%
School        |***************                       15/66 = 23%
Social Act.   |*****                                  5/66 =  8%
Shopping      |****                                   4/66 =  6%
Recreation    |***                                    3/66 =  5%
Other         |**                                     2/66 =  3%
```

Some Selected Respondent Comments: School and Social activity are "equally balanced".

Q6: Can you *change* your schedule to avoid traffic peak hours?

Purpose of Question: Determine whether ramp delays and freeway congestion would encourage people to change trip time. (Test of willingness/feasibility)

Analysis of Answers:

Number of people who answered the question = 66

Yes =31 rate=31/66 = 47 %

No =24 rate=24/66 = 36 %

Uncertain=11 rate=11/66 = 17 %

Some Respondent Comments:

- Office closes at 5:00 [no flexibility]

Q14: Again, assume ramp control really makes your trip much smoother and faster on the freeway, what would be a ***maximum*** time you are willing to wait at the ramp before you start to think about an alternative route/ramp?

Purpose of Question: Determine limits of wait time as expressed by users.

Analysis of Answers:

Number of people who answered the question = 62

0 minutes	*	1/62 = 2 %
5 -10 seconds	*******	7/62 = 11 %
10-20 seconds	******	6/62 = 10 %
Less than 1/2 minute	**********	12/62 = 19 %
Less than 1 minute	*******	7/62 = 11 %
1-2 minutes	**********	14/62 = 23 %
3-5 minutes	********	8/62 = 13 %
6-9 minutes	*	1/62 = 2 %
10 minutes or longer	**	2/62 = 3 %
Open+	****	4/62 = 6 %

+ Accept judgment of traffic experts

Needed Corrections (for San Diego Survey): None

Q15: Given the traffic volume you see every day at this ramp, do you think the ramp is operated efficiently?

Purpose of Question: Determine if people are dissatisfied with current waits and delays.

Analysis of Answers:

Number of people who answered the question = 65

Yes = 38	rate=38/65 = 59 %
No = 8	rate= 8/65 = 12 %
Don't Know = 19	rate=19/65 = 29 %

Needed Corrections (for San Diego Survey):

- May eliminate the entire question. Question 12 should be sufficient.