Development of a Pavement Management System for the City of Indianapolis

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INTRODUCTION

The Indianapolis Department of Transportation (IDOT) has over 3100 miles of city streets and county roads under its jurisdiction. With such a large transportation network to maintain and upgrade, the department has searched for a number of years for a method or technique it can employ to optimize the management of it's system of roads and streets.

BACKGROUND

During the past ten years a procedure has evolved whereby a priority code is assigned to each street for which some corrective action is indicated. IDOT's Resurfacing Section is responsible for surveying each street which has been identified as needing some form of corrective action. Identification of the streets to be surveyed is accomplished either by responding to requests from private citizens, or requests from district garage superintendents or requests from other DOT city officials. During the street survey a priority code is assigned by a team of two raters indicating when some form of corrective action should take place. In addition to the requested streets, all thoroughfare streets are surveyed on an annual basis and assigned an appropriate priority code. The priority codes are:

1A	Highest Priority	— correct pavement deficiency this year
1	High Priorty	— if street is a thoroughfare correct this year, other streets as resources permit
2	Future Priority	— correct pavement deficiency in the near future
3	Low Priority	— pavement corrective action can be deferred to some time in the future
	Spot Repairs	— corrective need can be handled by isolated repairs

The present priority code system has functioned well. However, the system is highly dependent on one or two key individuals and is extremely subjective in nature. The accumulation and synthesis of street condition data for priority ratings has become an ever increasingly complex task which requires significant time commitments from a few key IDOT personnel.

Beginning in the fall of 1984 Fred Madorin, director of the Indianapolis Department of Transportation and John Willen, chief street engineer, IDOT, realized that a new system should be developed to properly manage IDOT's street inventory. Initially an in-house study was started in an attempt to develop a pavement management system (PMS). However, because of an extremely heavy workload an outside consultant, James L. McKinney, was retained to handle the initial feasibility study and subsequently, the design and implementation of an IDOT PMS.

PAVEMENT MANAGEMENT

Pavement management is an elusive term which can mean different things to different people. However, an AASHTO joint task force stated:

> "Pavement management is the effective and efficient direction of activities involved in providing and sustaining pavement in an acceptable condition at the least life cycle cost."

The Road and Transportation Association of Canada indicates:

> "The basic purpose of a PMS is to provide the best value possible for available public funds."

Hass and Hudson in their textbook *Pavement Management Systems* states:

> "PMS is a comprehensive, coordinated set of activities associated with:
> - — planning
> - — design
> - — construction
> - — maintenance
> - — evaluation
> - — research
>
> for highway facilities."

PRELIMINARY INVESTIGATION

The preliminary investigation into the feasibility of a pavement management system for IDOT involved providing answers to the following questions:

Is the pavement management concept a feasible undertaking for IDOT?

What is the current state of the art of pavement management?

- What are other city and county and state agencies doing?
- What systems are presently available?
- What can be used by Indianapolis?

What type of system should be implemented?

Who should develop the system?
Outside consultant?
IDOT personnel?
Combination IDOT/consultant?

All key IDOT personnel were interviewed regarding present highway inventory management and were specifically asked to comment on the feasibility of a pavement management system. Input was also obtained from IDOH — specifically the division of planning as well as the Research and Training Center. An important consideration that became apparent during the investigation process and which was utilized during the subsequent design and implementation process was the need to include key IDOT personnel in the planning, design and implementation process. As a result an advisory committee was formed to guide the consultant during his investigation and to provide input into the design in order to comment on what an ideal system should be and what attributes the system should have. Members of this committee were selected from all IDOT operational areas.

The consultant's investigation and query of key IDOT personnel and advisory committee members resulted in the development of a set of objectives and goals and benefits and outcomes for a pavement management system. See Table 1. At this time it also became apparent that the most desirable method for implementing an IDOT pavement management system would be via a joint arrangement between the consultant and IDOT.

PAVEMENT MANAGEMENT INFORMATION SYSTEM

The most important component of any pavement management system is the highway inventory or the pavement management information system (PMIS). According to an AASHTO Joint Task Force on pavement management:

> "PMIS is an established and documented procedure for collecting, storing, processing and referencing information required in a pavement management system. It is the foundation of pavement management."

A point emphasized by all advisory committee members as well as by other key individuals surveyed was that the success of the pavement management system was highly dependent on the choice of or the development of an appropriate PMIS. It also was readily apparent early in the development of the system that the information system must be a computerized database that would be flexible enough to handle all of IDOT's present and future needs.

Several alternative information systems were considered — ranging from developing a new database to trying to utilize an existing database such as the Department of Metropolitan Development's database or IDOH's gas tax road inventory.

IDOH ROAD INVENTORY

After considerable study the IDOH gas tax road inventory was chosen. Several reasons made the choice of this database obvious:

1. The database was readily available and already in place
2. The IDOH inventory consisted of an extremely detailed record of all Marion County roads and Indianapolis streets
3. Short street segments were already well defined

TABLE 1. GOALS, OBJECTIVES, BENEFITS AND OUTCOMES

I Maximize Use of Limited Funds
- Maximum Use of Available Dollars
- Cost Effective Pavement Selection
- Value Engineering

II Optimal Management of Highway System
- Maintenance vs. Resurfacing vs. Reconstruction Decisions
- Improve Chances of Making "Correct" Decision
- Identify "Good" Practice
- Identify "Poor" Practice
- Planning Efficiency with Feedback

III Data Base Inventory of Highway System
- Physical Attributes of Highway
- Section Mileage and Mileage Comparison with IDOH Inventory
- Traffic Information
- Administrative and Governmental Information
- Readily Accessible and Retrievable Data

IV Present Condition Assessment
- Rating System: Roughness, Serviceability & Structural Indexes
- Citizen, Governmental & Professional Input
- Determination of Present Rehabilitation Needs
- Identification of Rehabilitation Priorities
- Identification of Rehabilitation Costs

V Planning and Forecasting
- Incorporation of All Planning Information
- Identification of Long Term Pavement Performance
- Forecast Future Needs
- Rational Maintenance Program
- Rational Overlay Design
- Optimal Choice of Design Alternatives

VI Public Accountability
- Consequences of Various Funding Levels
- Ability to Respond to City Council Requests for Information
- Objective Data Supporting Funds Requests

VII Research
- Evaluation of: New Materials, New Construction & Maintenance Methods
- Evaluation of Quality Control Measures

VIII Training
- Users Manual
- Training Sessions
- Use of System by ALL DOT Employees
- PMS as an Educational and Training Tool

4. A significant amount of the data contained within the IDOH road inventory could be used in a IDOT PMIS. See Table 2.
5. City and county gas tax revenues are allocated based on the IDOH inventory.

A copy of the computer tape containing the IDOH highway inventory data base was acquired in order that the data be transferred to the city's mainframe computer. The inventory was then downloaded to an

TABLE 2. IDOH ROAD INVENTORY

Administrative Data
- City vs County
- RTEL — Street Coding
- SC — Section Coding
- ALOG — Mileage Coding
- Function Coding
- Federal Aid Classification

Segment Description
- Beginning Point
- Ending Point
- Segment Length
- Intersecting Streets
- Location of Intersecting Streets
- Street Direction

Street Cross Section
- Number of lanes
- Lane Width
- Surface Type
- Width of Shoulders
- Shoulder Type
- Right of Way Width
- Access Control

Other Miscellaneous Data

Roughness

Friction Value

Serviceability Rating/Index

ADT

Data Revision Data

operating system entitled "Focus" and "PC Focus". The choice of this particular operating system will allow the database to be accessed from either the city's mainframe computer terminals or IDOT stand-alone microcomputers.

The inventory was modified for IDOT use by retaining 27 fields, deleting 9 fields and adding 55 additional fields of information. The inventory is composed of approximately 300 bytes of information per record and approximately 30,000 records. See Table 3.

TABLE 3. IDOT PAVEMENT MANAGEMENT INFORMATION SYSTEM

IDOH Data to be Retained

1. Length = Segment length - 1/1000 mile - xx.xx miles
2. F = Function Class
3. S = Federal Aid
4. D = Direction
5. L = Lanes
6. LWS = Left Shoulder Width - feet
7. NT = North or East Bound Type
8. NW = North or East Bound Width - feet
9. MED = Median Type:xyy
10. ST = South or West Bound Type - same key for type as before
11. SW = South or West Bound Width - feet
12. TS = Type of Shoulder - same key for type as before
13. WS = Right Shoulder Width - feet
14. RUFF = Roughness
15. FRC = Friction Value
16. SI = Pavement Serviceability Index
17. SR = Pavement Serviceability Rating
18. TCP: T = Turns: not used
19. RWW = Right of Way Width - nearest 5 feet
20. A = Access Control
21. ADTVOL = Estimated Average Daily Traffic Volume: not being used
22. BYYMM = Added - Year/Month

23. RYYMM = Revised - Year/Month
24. RECORDX = Record Number - IDOH Use
25. RTEL = Route Number & Letter - Code for Street Name
26. SC = Section Number - Number of non-contiguous street sections
27. ALOG = Adjusted Log Mileage

IDOT Data to be Added

1. TWNSHP = Civil Township
2. COUNCIL = Council District
3. DOTMX = DOT Maintenance District
4. BM = Base Map
5. COORD = Coordinates
6. PD = Private Development
7. ACCPTD = Accepted
8. TP = Thoroughfare Plan
9. OP = Other Plans
10. IF = Importance Factor
11. SW = Special Weight Factor: Mayor, City Council, Dept Directors
12. UF = Use Factor
13. CT = Curb Type:XYYZ
14. DRAIN = Drainage:XYZ
15. DBASE = Design Base:TyThYr
16. DBIND = Design Binder: TyThYr
17. DSURF = Design Surface: TyThYr
18. CBASE = Constructed Base: TyThYr
19. CBIND = Constructed Binder TyThYr
20. CSURF = Constructed Surface: TyThYr
21. MAINT = Maintenance: TyThYr
22. MILL = Cold Planning: TyThYr
23. OLAY1 = Overlay #1: TyThYr
24. OLAY2 = Overlay #2: TyThYr
25. OLAY3 = Overlay #3: TyThYr
26. COREBASE = Core Base: TyThYr
27. COREBIND = Core Binder: TyThYr
28. CORESURF = Core Surface: TyThYr
29. SCBASE = Street Cut Base: TyThYr
30. SCBIND = Street Cut Binder: TyThYr
31. SCSURF = Street Cut Surface: TyThYr
32. NOSC = Number of Street Cuts
33. TPLAN = Traffic Planning
34. TRAF = Traffic:ADTYR
35. PTRKS = Percent Heavy Trucks
36. PDIST = Percent Heavy Truck Lane Distribution
37. FORTRAF = Forecast Traffic: ADYTR

38. EAL = Design Equivalent Axle Loading
39. CITZ = Citizen Request for Action: ABCXXDDMMYR
40. GOVN = DOT/Governmental Request for Action: ABCXXDDMMYR
41. MAYOR = Mayoral/City Council/Elected Official Request
42. RUFF = Roughness: inches/mile (previously identified)
43. LRUF = Last Roughness Measurement: MMYR
44. PSI = Present Serviceability Index: X.XXA(M)
45. LSCE = Last Surface Condition Evaluation: MMYR
46. PCI = Pavement Condition Index: 0 to 100%
47. LSI = Last Structural Index: MMYR
48. STI = Structural Index: 0 to 100% (ore more)
49. DFI = Deflection Index: Future value
50. CI = Cracking Index: XXX = 0 - 100%
51. NAME = Street/Road Name
52. XSTR = Cross Street Names
53. PC = Priority Codes - Previously assigned IDOT Priority Codes
54. NSWK = North or East Bound Sidewalk: WWTC
55. SSWK = South or East Bound Sidewalk: WWTC - see above

IDOH Data Items to be Deleted

1. S = Road System
2. CO = County - all Marion County
3. D = IDOH District
4. CITY = City Code
5. P = Population Code
6. MET = Metropolitan Code
7. U = Estimated Urban Area
8. J = Route Jurisdiction
9. RAMP = Milepost for State Highways

PAVEMENT MANAGEMENT INPUTS/OUTPUTS

Design of the actual pavement management system was facilitated by developing a set of desired system inputs and outputs. Once again the preliminary user survey and the advisory committee proved invaluable in guiding system development. The system inputs/outputs are summarized in the following categories:

Pavement Management Information System - Figure 1.
Present Condition Assessment - Figure 2.
Maintenance and Rehabilitation Actions - Figure 3.
Existing Pavement Structure - Figure 4.
Planning and Forecasting - Figure 5.
Design - Figure 6.
Economics - Figure 7.

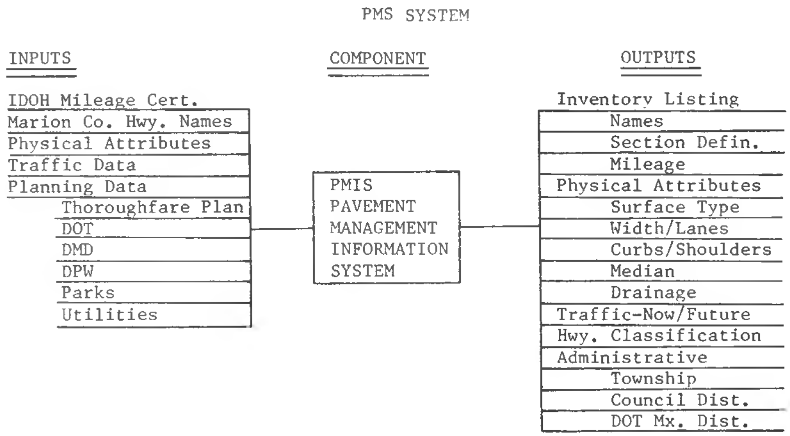
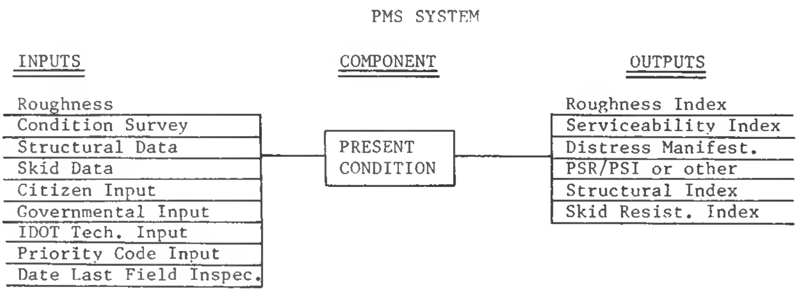


Figure 1.



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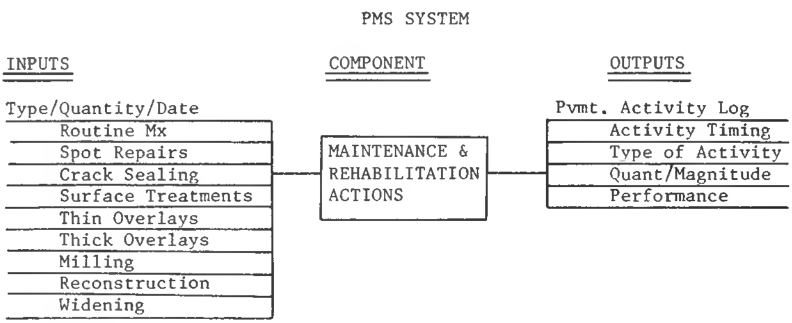

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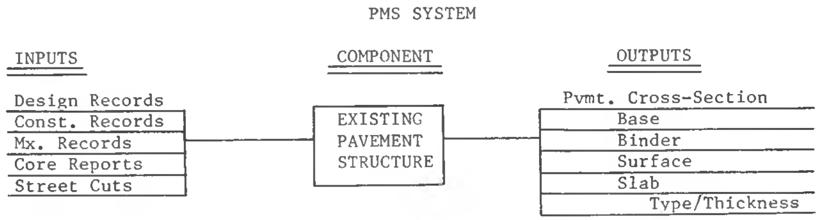
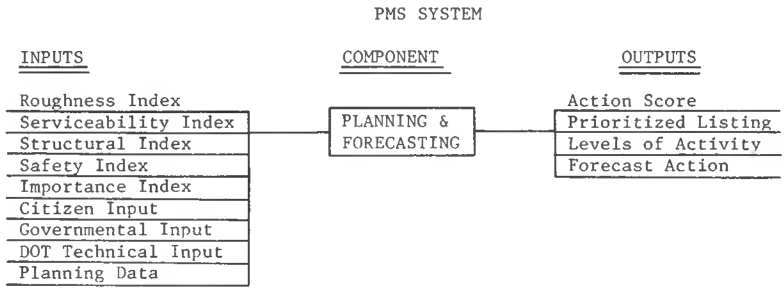


Figure 4.



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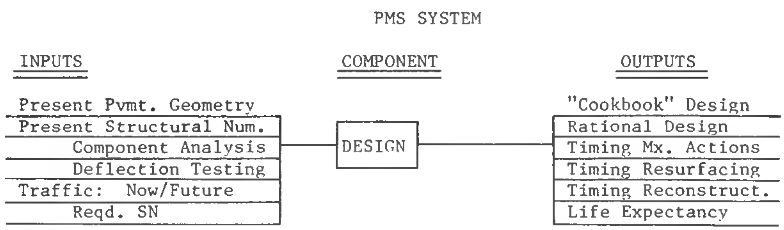

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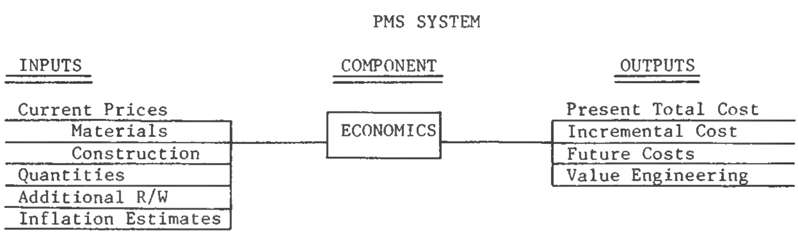

Figure 7.

PAVEMENT MANAGEMENT SYSTEM COMPONENTS

Using the inputs/outputs as a design tool a pavement management system activities flow chart was developed. The pavement management system which was designed can be divided into the following components:

Roughness: For a given segment a number of different "trigger" mechanisms will initiate a process which will determine the present serviceability rating or present serviceability index for a given highway segment. See Figure 8.

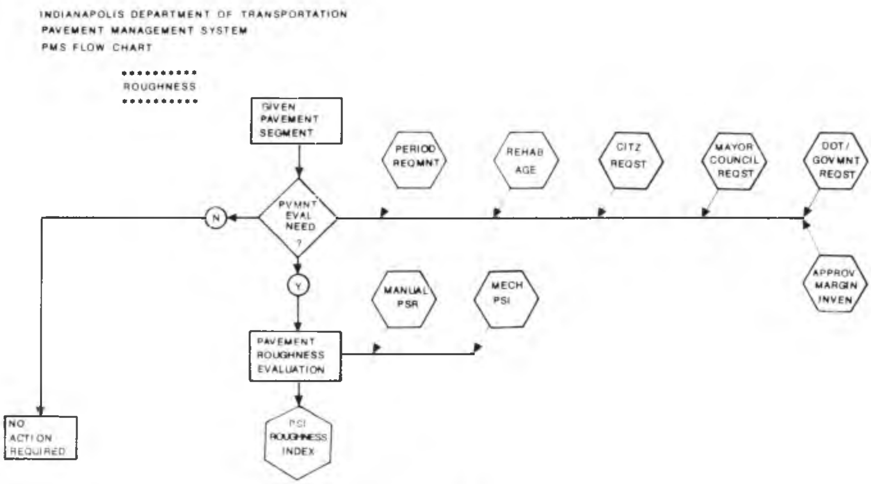

Figure 8.

Surface Condition: Those pavement segments which fall below a predetermined PSR/PSI cutoff value are then subjected to a present condition index rating - PCI. See Figure 9.

Structural Capacity: The pavement segments with a PCI which falls below a predetermined PCI cutoff value or those segments identified as being deficient in other desirable attributes are subjected to a structural capacity evaluation — either by deflection testing or by component analysis. By utilizing the existing structure information as well as current traffic information a Structural Inex (STI) can be computed. The STI is equal to required structural capacity divided by the existing structural capacity. See Figure 10.

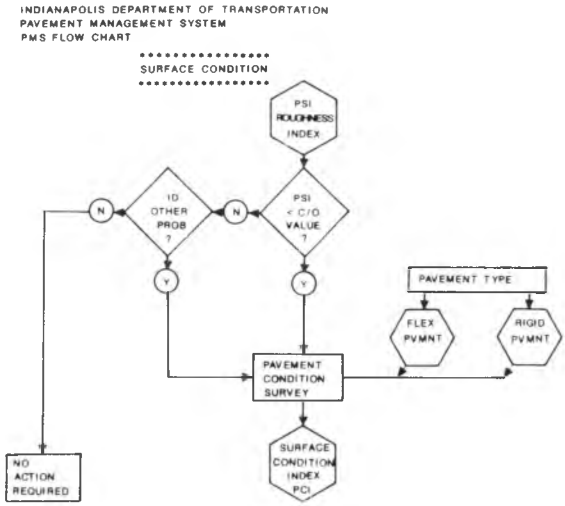

Figure 9.

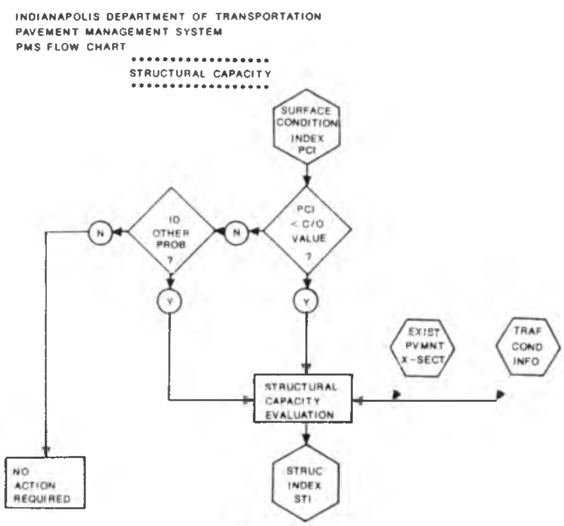

Figure 10.

Overlay Design: Based on the STI one of several rejuvenation/resurfacing/reconstruction alternatives is proposed. Several other factors, such as drainage needs, future planning information as well as departmental preference, are also taken into account when generating alternatives. See Figure 11.

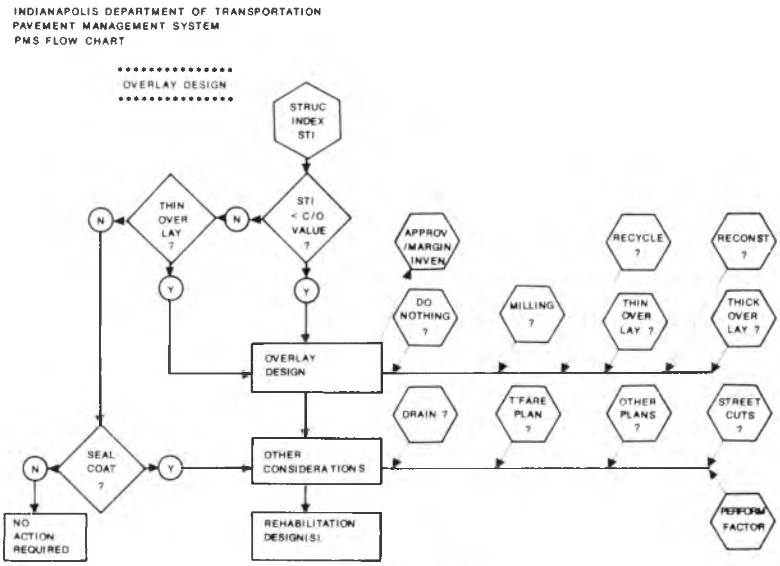

Figure 11.

Value Engineering: All identified rejuvenating/resurfacing/reconstruction alternatives are subjected to a value engineering analysis in order to select an appropriate and economical plan of action for the street segment in question as well as the system in general. See Figure 12.

CLOSURE

Implementation of the IDOT PMS is well under way. Training programs, such as present serviceability ratings and present condition index ratings, were conducted for IDOT inspectors and system administrators during the winter of 1985/1986. Current plans call for a pilot program for the city's thoroughfare plan streets to be in place during the winter of 1986/1987.

It is anticipated that the IDOT PMS will be a dynamic system which will change as time and conditions warrant. However, with the proper development and careful nurturing PMS should become a valuable tool to assist in the management of the IDOT highway system.

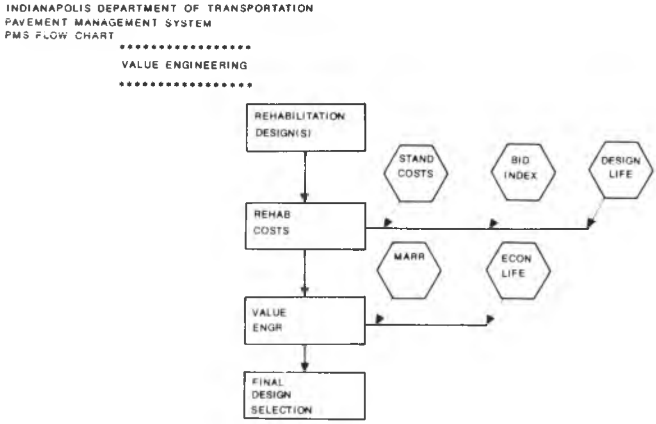

Figure 12.