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16. Abstract

This study was undertaken to address the problem of rapid turnover of young engineers in Louisiana DOTD. Research has indicated that a program to professionalize engineering positions has been successful in other states.

Based on successful experiences elsewhere, a process has been suggested here, called the Engineering Resource Development Program (ERDP). The ERDP includes a formalized rotation plan so that every new engineer is exposed to each major engineering section in order to learn the department's responsibilities and opportunities. At the end of rotation, the engineer and the Louisiana DOTD can then make an informed decision as to where it is best for the engineer to begin his career.

To further motivate the engineer (old as well as new), a formal continuing education program should be created to allow technical employees to increase their skills and prepare them to move into management. The Louisiana DOTD is a technical organization and it needs technical managers. The continuing education program should facilitate every engineer's becoming a professional registrant.

A formalized appraisal scheme to judge the program as well as the individual is suggested. Additionally, a training program is suggested so that supervisors can be better positioned to work with the ERDP.

In order to ensure maximum effectiveness, a program coordinator is suggested and a list of tasks in which he should becom involved is enumerated.

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INVESTIGATION TO INCREASE PRODUCTIVITY AND RETENTION OF YOUNG ENGINEERS

Final Report

by

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Research Report No. 220

Research Project No. 88-2SS(B)

Conducted by
DEPARTMENT OF INDUSTRIAL ENGINEERING
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for

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August 31, 1988

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ABSTRACT

The Louisiana Department of Transportation and Development (DOTD), like most state departments of transportation, has experienced a problem in retaining young engineers. It is felt that productivity and motivation considerations are a part of the problem.

Accordingly, methods to overcome these problems were researched. It is recommended that DOTD institute a program, to be known as the Engineering Resource Development Program, to include the following steps:

(1) Require all entry-level graduate engineers to participate in a rotational training program wherein they receive information about all sections of those organizational units that use engineers. This exposure, in effect, places them in a technical and management training program to form a pool of talent from which DOTD management can choose future managers.

(2) Offer an ongoing continuing education program to enhance the "value" of new engineers to DOTD and refresher programs to assist them in becoming registered professional engineers. A continuing education program assures the participant that his continuing development is of concern to DOTD, thereby further motivating him.

(3) Appraise, on a regular basis, both the program and the participants. A format for this appraisal was developed.

(4) Train the current DOTD engineering section managers in the application of the program to their sections.

(5) Assign a program coordinator to manage the Engineering Resource Development Program. A list of responsibilities for the coordinator is recommended.

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INTRODUCTION

The Louisiana Department of Transportation and Development (DOTD) has, in the past years, experienced an unusually high turnover of engineering personnel. This research proposes to develop a program to aid in the retention of engineers and to allow the department to make better use of technical personnel. This study will only investigate the internal variables which can be controlled within DOTD; thus no attempt will be made to consider monetary incentives or the civil service system.

The investigation was prompted by the realization that a large number of engineers were recruited by the department, obtained some level of experience, then sought employment elsewhere using the experence that they obtained in DOTD.

A survey of the engineering section heads indicates a widespread belief that there is little understanding among new engineers as to the scope of the responsibilities throughout the entire DOTD. Because of this situation, the engineer is often unaware that there is a need for his area of interest in sections other than that in which he was initially hired. It is also the opinion of the section heads that engineers would be more motivated in their jobs if the section head had an opportunity to work with all new employees and could identify their areas of interest.

Meetings with individual engineers, both at headquarters and in the districts, indicate that there is a need for a continuing education program. Those engineers expressed disappointment that they are not continually updated in their profession and indicat-

ed that they receive insufficient assistance from DOTD in rectifying this particular problem.

It was also indicated by the survey group that there is no formalized process for orienting new engineers as to the procedures, processes, and technical data bases in DOTD; therefore, the newly arrived engineer must accumulate this information in a somewhat haphazard manner.

A review of the literature indicates that these problems are not unique to Louisiana. Many other state departments of transportation have encountered these and similar problems.

The Minnesota Department of Transportation has utilized operational and tactical human resource planning for several years. They have two separate programs: The Construction Engineering Manpower Management System, which requires from 6 to 18 months to complete, and the Project Management Scheduling System, which requires 1 to 5 years to complete. These systems are used for programmed projects and more for management of existing personnel than for justifying changes in the number and skills of employees.

The North Dakota Highway Department has recently made a major commitment to implement a human resource planning program. In instructing its managers how to proceed to develop such a program, agency administrators emphasize that projections of human resource requirements are influenced by technical changes, planned efficiency steps, and changing priorities.

The Virginia Department of Highways and Transportation has an ongoing work force planning process. The human resource planning system is automated and has been operational since July

planning system is automated and has been operational since July 1983. The system consists of two elements: 1) a work load assessment system, which determines demand for personnel; and 2) a tracking system for forecasting, analyzing and controlling the supply of personnel.

California's systems approach to transportation management recognizes the need for a comprehensive system, with all resource needs tied together, that can respond to changing processes as they occur and provide managers with complete, timely, and comprehensive information and options to enable them to make decisions.

The Maine Department of Transportation's Bureau of Project Development, which is responsible for pre-construction engineering, forecasts work force needs based on the availability of federal and state funds.

Pennsylvania is evaluating each section of its agency as part of a business group contributing to the group mission and objectives. Information will be developed to demonstrate how functions are utilized to meet objectives through linking missions to objectives, examining functions at organizational levels, and linking them to objectives and to key managers.

The New York State Department of Transportation decided to proceed with the development and installation of project monitoring and personnel resource management scheduling. A task force was established from various functional areas to implement the system. It is expected that the system will provide the agency with a more effective way of manning projects and meeting section needs.

Although none of the above-described state efforts exactly parallels the problems which have been encountered by the Louisiana DOTD, valuable insight as to the approach to those particular problems was gained through a study of those systems.

Definitions of "professional" vary widely, from "someone employed in an occupation" to "a person educated or trained and then licensed or certified to practice in a field." (1) Traditionally, "professional" has been accepted to mean a member of an occupation where practice and entry into the field was regulated by government for reasons of the safety, health and welfare of the public. State and local licensing and registration boards have long controlled access to the practice of medicine, law, education, engineering, and various other professions.

The Bureau of Labor Statistics (BLS) identifies a category of workers called "professional, technical, and related workers." This heading includes engineers, drafters, surveyors, civil engineering technicians, computer specialists, and physical, life, and social scientists but excludes managers, officials, mechanics, and construction craft workers.

For the purposes of this study, the term "professional" will refer only to graduate engineers.

In its proposed program for professional resource planning, the Minnesota Department of Transportation describes professional resource management as a future-oriented concept that deals with policies, plans, analysis, systems and methods that are used to establish and implement programs to develop an effective work force. From the employees' viewpoint, a professional resource plan has been described as an attempt to reconcile an individual's needs for the future with the needs of the organization.

must be a continuing activity; it should be updated regularly to take into consideration new technology, the overall economy, and the changing needs of an organization. Another ingredient for success is that a professional resource plan be organization-wide and given the continuous support and participation of senior management.

The importance of professional resource planning is recognized by administrators in both public and private organizations. At the time of rapid advances in technical and managerial knowledge, spiraling labor and material costs, and changes in public funding policies, management must be able to ensure that the right number and kind of employees are in the right place at the right time.

A still broader view, as one state official has pointed out, is that the only real purpose in considering employees as resources is to accomplish the agency's goal: that is, to build better roads in more effective ways with the best use of the talent available. The only way to accomplish this is through a dynamic human resource plan that has management's total commitment.

Professional resource management, then, can be viewed as a management tool that can: (a) help determine professional recruitment and promotion requirements; (b) determine the kind of training, retraining and career development programs the agency needs to meet its program requirements; and (c) forecast professional supply in terms of changing organizational needs.

A professional resource plan should include the following components:

1. An overall organization analysis that attempts to identify the professionals needed to achieve the agency's goal (this could include projected changes in work load, labor mix, and departmental policies);

2. An analysis that determines the behavior and skills necessary to perform specific tasks;

3. Person analysis that seeks to identify the skills and abilities an individual needs to perform specific tasks;

4. Recruitment policies and programs, including the number and level of recruits;

5. Projected shortages in specific professional categories that can be determined by analysis of data on external labor demand and supply, as well as internal department data on the age structure and projected retirement of employees; and

6. Training and promotion plans for various professionals categories.

To administer the program, DOTD must establish a Management Rotation Committee. This committee's responsibility will be ensuring that the placement of graduate engineers takes into consideration the relative priorities and personnel needs of the

rotation and will be responsible for the direct implementati
each individual rotation plan.

PROGRAM OBJECTIVES

A. To familiarize the engineer with the various sec
and district opportunities of DOTD through lecture
on-the-job training.

B. To assist the engineer in defining his specific,
term career interests.

C. To provide formal training opportunities for pr
sional, managerial and technical growth through co
uing education programs.

D. To provide work environments conducive to the dev
ment of managerial talent for DOTD's future operat

E. To provide DOTD's management an opportunity to ob
and evaluate the capabilities of engineers.

PROGRAM REQUIREMENTS

A. The rotation program will be mandatory for all
neers entering DOTD. Rotation assignments and
tables may be adjusted by the Program Coordi
according to previous work experience.

B. District and headquarters supervisors will be respo
ble for implementing the on-the-job training of
neers. The Program Coordinator will hold peri
reviews with supervisors and engineers to
progress on the work plans and ensure that the rot
experience is proving beneficial to both the engine
the office/district.

C. Engineer rotations will only be used to fill nonpermanent positions.

D. All rotating assignments will follow the work plan for training approved in the DOTD Professional Engineering Resource Management Program.

E. Engineers will meet periodically with the Management Rotation Committee to discuss their rotation programs and career goals to further motivate the engineer.

PROGRAM IMPLEMENTATION

A. The duration of the Engineering Resource Development Program will usually be 24 months at headquarters and 18 months at the districts. However, if an engineer has experience prior to working for DOTD, he may be eligible for the Engineer-in-Training 2 classification before the full time period, and adjustments may be required.

B. Each rotation period will have a finite time limit. Exceptions may be made with approval from the Program Coordinator.

C. To provide the engineer an opportunity to meet with key engineering staff while broadening his understanding of the department's various functions, interviewing arrangements will be made by the Program Coordinator for the engineer with the various engineering section heads within the department. After the initial orientation process, the engineer will work with the Program Coordinator to develop his proposed rotation plan and will

FUTURE PROFESSIONAL NEEDS IN STATE HIGHWAY AGENCIES

Combining both retirements and growth yields a nationwide need for new engineers in highway agencies equivalent to 4.9 percent of the total engineering work force in these agencies, or about 1,450 more employees per year (1984) as shown in Table 3. (2) Figure 1 (1) shows that nationwide this need is not difficult to fill. The nation's colleges and universities graduate about 10,500 bachelor's degree civil engineers and 3,000 master's degree civil engineers each year, and if state highway agencies continue to attract their proportional share of these graduates, they will continue to be able to hire in a market where there are more candidates than jobs for the next 2 or 3 years. All civil engineers are not transportation engineers; and in view of the current shortage of transportation engineers, there is no reason to believe that this shortage will disappear in the foreseeable future. The data depicted in Figure 1 was collected in 1984 and appears at variance with the latest engineering enrollment data.

After that time, the difficulty in hiring could increase somewhat if current trends continue unchanged. Yet at least three departures from these trends might be anticipated.

* Civil engineering could attract a constant or even an increasing share of engineering students. The declining popularity of civil engineering within university programs relative to other fields of engineering derives in part from civil engineering's relatively

students will hear about potential jobs in civ
engineering and more students may select civ
engineering as a field, thereby helping to avert
shortage of candidates that might occur if curr
trends were to persist unchanged.

* More graduates of civil engineering programs could
professional positions in which they practice c
engineering rather than shifting to other fields.
fields where skills are in short supply, such
computer specialties, more than one out of every
jobs are filled by persons trained in other a
Figure 2 is a reflection of labor ma
adjustments--field switching--in order to accomm
shortages and surpluses of personnel trained
specific discipline. The high ratio of non-com
specialists holding computer jobs to those educat
computer science reflects the large number swit
into computer fields from other disciplines.
instance, over 2 technically trained individual
switching into computer specialities for every on
trained. The reverse has been true of civil
neers: Only 80 percent or so of graduate civil
neers practice civil engineering and the remainde
in other areas. As the market for civil engin
graduates improves, fewer graduates are likely to
the field for positions elsewhere.

* Highway agencies facing greater-than-normal nee

relative to private industry and other pot
employers of civil engineers. State highway age
employ about 17 percent of all practicing c
engineers, and a larger share might be drawn the
needed and if these agencies can successfully co
for them. Other projections of civil enginee
employment, however, show non-highway applica
growing more rapidly than the highway-agency
assumed here. (2)

These kinds of likely adjustments mean that there pro
will not be a shortage in the number of new civil engine
graduates through 1999. Instead, the problems faced by
state agencies include not being as active as possib
recruiting new engineering graduates; facing abnormally
requirements to replace senior and mid-level positions for
new graduates are not sufficiently prepared (although the pr
sector can fill this gap to some extent); and finding
professional employees are not willing to accept interna
rotations that help to develop seasoned professionals becau
high residential location costs and other factors. (2)

In addition, the declining role of transportation engi
ing in civil engineering education programs may be creating
long-run difficulties. The best students may not be ent
civil engineering. Highly publicized fields like elect
engineering, computer science, robotics, and genetic engine
will continue to be attractive and to have the greatest de
Also, a decline in the number of U.S. citizens earning docto
in civil engineering, together with continued lack of grow

nrollments in civil engineering departments, may eventually reduce the number of professors who train graduate civil engineers.

At the same time, the focus of the highway program is shifting. While new construction projects, including major ones, have continued to occur and new skill- and labor-intensive interchanges, intersections, and lanes are constantly being added, the main emphasis of highway programs is changing toward rehabilitation of existing facilities, which requires not only the same types of skills needed by engineers in the past but also new ones. More emphasis is being placed on the economic, safety, and environmental aspects of highway transportation. The technology used by highway professionals is also changing as computers, satellite photography, new materials, and other new technologies alter the way tasks are performed.

The incentives to encourage professional development may be changing as increasing numbers of households become two-income families. More and more women have been entering engineering fields and in turn entering highway agencies.

Taken together, the changes occurring within and outside state highway agencies create some distinct professional needs. Drawing attention to these needs may help these agencies take whatever steps are appropriate to fill or reduce them, as the case may be.

Three of these needs which are particularly pressing are discussed in the following sections:

* Training of lower and middle management engineers,
* Shifting the mix of skills needed,

* Maintaining a competitive position in recruiting en level professionals.

States already attuned to these needs are taking a var of actions to make their agencies more productive. A substan number of organizations have reported that a concentratio training and the use of technicians, consultants, and compu has had a large effect on their ability to meet t professional staff requirements. Table 4 describes the rela effectiveness of actions which serve as incentives to enhance engineer's position, thereby causing him to remain with transportation department.

TRAINING OF MID-LEVEL AND MANAGEMENT ENGINEERS

Many state highway agencies will soon face a pressing to refill management positions with seasoned, broadly experie engineers. Nationwide, one of seven managers in state hig agencies is likely to retire within 5 years. Most of th positions will probably be filled through promotion f engineering positions, as they have been in the past. magnitude of this cycle of replacement, however, is la because a much-larger-than-normal increase in state hig employment occurred between 1945 and 1960, particularly while Interstate system was being constructed. Although the defini of career paths is desirable, the many opportunities transportation department management precludes build inflexibility into the system by so defining the paths.

Assuming that almost all of these managers retire at age 62, whe professionals are eligible for social security benefits (also th mode of the retirement age among states), then about 930 manager will retire before 1990, an average of 19 per state. A simila number or perhaps an even larger number is likely to retire i the following 5 years, bringing the total to nearly 2,000 durin the next decade. Because these retirements are not evenl spread, many states will face a turnover of a substantia fraction of their senior staff, beyond the fluctuations i attrition that may occur.

In the aggregate, there are nearly 18,200 engineers in th 36-55 year age group, and many of these will probably be promot to replace the approximately 2,000 managers who will retire 1995. Although there are numerous replacements availabl throughout the country, and therefore this is not a nation problem, there are likely to be many specific situations in whi suitable in-house candidates are unavailable or inadequate prepared.

Many states will intensify their special training progra to prepare professional staff to assume the responsibilities managers who retire. In response to a 1984 AASHTO surv questionnaire asking which steps agencies had taken to incre the effectiveness of their professional work force, it was fo that various training activities are widely used and have pro beneficial. Almost all states and the District of Columbia of 50 respondents) have introduced or expanded their in-ho management training courses, 47 have sent professionals

introduced or expanded technical training programs for professionals. Although relatively few states reported that individual steps of this sort had a large effect, most reported the effect to be moderate.

One form of professional development that many agencies rely on is to rotate a professional's job assignments--to different functions, different divisions, or different responsibilities--so that professionals develop a better understanding of the mission and workings of the agency as a whole, thereby preparing them to manage effectively.

As engineers and managers are rotated throughout the organizational structure, they gain the experience and insight necessary for senior positions. Job rotation often requires physical relocation, however. For example, supervisory assignments may entail overseeing activities in some particular region of a state.

Some state administrators report that they find increasing resistance among their professional staff to the acceptance of assignments that require relocation, which thwarts one of the channels for developing managerial talent. Although the increasing proportion of two-earner households may impede some relocations, the factor most often cited as probably the biggest barrier is the high cost of relocation. Taking out a new mortgage may mean accepting a higher mortgage interest rate. Selling a home amid current economic conditions may entail making two sets of house payments until the previous home has been sold or it may entail selling the former home at an unattractive price. Although most states pay the transportation moving

expenses of employees who are reassigned to new positions th require relocation, only two states (Oregon and Wyomin compensate employees to ease the inconvenience of moving or pay for such costs as increased mortgage rates, reduced selli price, and real estate fees. For example, Oregon will purcha management and executive service employees' homes and pay percent of the appraised value to facilitate relocation to a n headquarters at a minimum distance of 35 miles away. Thi appears to be an effective method for removing one of the ke barriers to professional reassignment, and other states faci exceptional future needs for new senior professionals might fi that enactment of similar provisions could substantially impro their ability to develop the needed talent in-house.

In addition, new training programs might be specifica geared to the development of professional engineers so that the can acquire all the skills and perspectives needed to repla retiring top employees. For example, for 20 years the Universit of Mississippi's Highway and Transportation Management Institu has offered a 3-week program each year to teach gener management theory and concepts mostly to civil engineers i management positions or entering such positions. In addition the University of Virginia recently began a program for briefi new top-level highway administrators on the key issues, trends and changes that affect the agencies. New programs of a simil sort targeted at management engineers might meet the specia developmental needs caused by the accelerated rate of retirement from state highway agencies anticipated in the coming years.

SHIFT IN THE MIX OF SKILLS NEEDED

During the past 20 years there has been a shift in total highway disbursements at all levels of government from capital improvements to maintenance (Figure 3). This trend is reflected in part by a shift in functional responsibilities of highway engineers at the state level.

In 1954, 76 percent of the engineers were involved in location studies, design, and construction and 5 percent in maintenance. In 1984, 66 percent of the engineers were involved in design and construction and more than 9 percent in maintenance. Today few engineers work on location studies for new highways.

State highway agencies anticipate further changes in program emphasis during the next 5 years. Nearly 90 percent of the states expect rehabilitation work to increase, 70 percent anticipate that bridge work will increase, and 69 percent expect maintenance to increase. Most states (54 percent) anticipate that their traffic operations work will remain at current levels. Although some states expect major construction activities to increase, a larger number expect a decrease in this activity (Table 5).

States indicated that a 25 percent increase in the real-dollar value of their highway program would particularly increase their need for three types of skills: highway design, construction inspection, and maintenance management.

In the AASHTO study, states were particularly emphatic in computer programming and systems analysis

and flexible. They were developed after discussions with the project review committee, all relevant section heads, and selected district and headquarters personnel. Table 7 provides a consensus from those groups. It is anticipated that the rotation program will go through a pilot run, after which it will be adjusted as the result of a critique.

It is recognized that the three primary training modes for such a program are lecture, orientation and on-the-job training. It is also recognized that in some cases the trainees will be introduced to the subject matter describing the methods and procedures. This is particularly advantageous where the process to be learned is very time-consuming. It is also prevalent where the calculations or experience is repetitive or where the real-time experience is not available for the trainee. The appropriate mix of lecture, orientation and on-the-job modes must of necessity be flexible and might change with each class.

Further, it would seem practical to have an initial orientation period for each class (preferably) or engineer. The purposes for this are twofold: first, the trainee will be introduced to the organizational environment of DOTD and become aware of the individuals filling key positions; second, he should realize that the time and effort devoted to him during this initial period is an indication that he is considered a valuable asset.

Periodically, all districts and headquarters trainees should meet, preferably every 6 months. Outside speakers could be used in conjunction with a dinner. This would be a morale-builder and motivator for young engineers.

M COORDINATOR

n any program such as that envisioned here, (see the sota program in the section, "Background Literature "), good management practice dictates that a full-time inator be assigned to the ERDP. This coordinator must be ved in the following tasks, as a minimum, in order for the am to be successful.

(1) Monitor on-the-job rotation training program. The ry thrust of the Engineering Resource Development Program in the on-the-job rotation training given to each young eer. This particular system requires that each engineer a specific amount of time in each section, following a am which acquaints him with the business conducted by that on. The program coordinator must maintain records so that ndividuals in the program are rotated as required and coor- tion with the previous department and the next department be conducted by the program coordinator.

(2) Analyze and project needed skills. The program coor- tor must maintain contact with the various sections, both he headquarters and at the districts, so that he may know the re needs of those sections. The scope of the coordinator's collection efforts should center around technical as well as neering personnel.

(3) Coordinate EIT and PE training refresher courses. The dinator must continue to maintain contact with the colleges ngineering and continuing education departments of the var-

when the engineer-in-training and the professional engineers refresher courses are offered so that DOTD personnel may take advantage of those programs. Additionally, where the programs are not available, the coordinator must arrange for the DOTD personnel to have those courses offered.

(4) Conduct orientation program. It is the coordinator's responsibility to schedule each section involved in the orientation program, so that source material, outlines, and lectures will be provided by that section for the orientation program. Additionally, the coordinator arranges the schedule and notifies the students for the training program. The coordinator should review the material with each section head to maintain continuity and similar standards so that the program is balanced.

(5) Coordinate continuing education activities. One of the primary aspects of the Professional Resource Management Program is that of lifelong or continuing education. These activities should continually upgrade engineering and technical personnel in their fields and provide them with necessary information so that they may enlarge their jobs and expand their opportunities. The subject matter of the continuing education activities will of course change from time to time, but it is the task of the coordinator to meet with each section employing engineering and technical personnel and identify those programs which can be of benefit to DOTD. The programs can be identified from within DOTD or the coordinator can actively place himself on the mailing list of various providers of continuing education so that he might be aware when specific programs are being offered

BACKGROUND LITERATURE SURVEY

REPRESENTATIVE PROGRAMS

The following are descriptions of agency-wide professional resource programs in various stages of operation in seven states. These programs are described in detail because they seem to include all the elements necessary for successful professional resource management and because they address some of the problems highway agencies face today and will face in the near future.

MINNESOTA

The Minnesota Department of Transportation (Mn DOT) has done operational and tactical human resource planning for several years. Two systems are used: the Construction Engineering Manpower Management System for short-range projections (6 to 18 months), and the Project Management Scheduling System for project design staffing projects (1 to 5 years). These systems are used for programmed projects and are more for management of existing personnel (staffing and assigning people, adding temporary help for construction) than for justifying changes in the number and skills of employees.

In 1980, a demonstration project for an overall human resource plan was initiated involving five percent of the Mn DOT employees. The target date for completion was June 30, 1984.

In devising its human resource plan, Mn DOT concluded that the most important benefits of the program would be (a) to routinely provide human resource planning information for use by management, (b) to stimulate employee motivation by letting

employees know where they stand in the organization, (c) to provide a long-lasting program that crosses functional lines and remains compatible with future changes in component subsystems, and (d) to provide improved credibility with the public and the state legislature.

Priorities for the Minnesota plan were identified as:

1. Developing a human resource planning policy that demonstrates management's commitment to a program that meets management's needs while ensuring that it is also good for the employees.

2. Establishing a human resource inventory that would contain position requirements, skills, demographics, and employment history.

3. Developing a process for work force planning that would include forecast modeling and coordination with existing systems. The expected output would be (a) demand forecasts of work force needs at prescribed budgetary levels that have been identified by strategic and tactical planning efforts; (b) supply forecasts of available personnel and skills obtained from the human resources inventory; and (c) environmental scanning to identify factors outside the department's control that could affect future hiring activities, transfers, promotions, etc.

In its proposal, Mn DOT noted that one of the critical elements required for successful planning is the availability of real time information--the better the information, the better the output that is possible. Accordingly, it was decided that the ultimate goal would be a computerized data bank primarily for

4. Reorganization. Transportation agencies are being restructured at the federal, state, and local levels to respond to emerging needs. This institutional change is requiring increased coordination and communication between transportation professionals. Significant restructuring also is occurring in the private sector.

EDUCATIONAL NEEDS

Transportation professionals require education and training in the eight general areas identified below to effectively meet tomorrow's challenges. To the extent that existing educational programs fail to meet these needs, transportation agencies will face a shortage of graduates with the requisite skills.

1. Broad-based education. The transportation professional must have the flexibility to adapt to new and changing circumstances. This can be fostered through exposure to a broad curriculum with strong emphasis on the fundamentals.

2. Communications skills. Excellent writing and speaking skills are required for the professional to communicate problem definitions and solutions and to foster implementation of those solutions.

3. Computer skills. The professional should be comfortable with the application of computer technology to transportation problem solving.

4. Analytical skills. Transportation programs have traditionally emphasized development of skills in technical analysis. This traditional emphasis is still needed, but the transportation professional also needs to be proficient in areas

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PROFESSIONALISM AND REFRESHER PROGRAMS

The practices in human resource management will always be evolving. Civil engineers have traditionally performed many transportation functions, particularly in state departments of transportation. Usually states have established necessary certification procedures to ensure technical competency in design and construction safety associated with large expenditures of taxpayers' funds. Such procedures have also helped to insulate professional staffs from political patronage and to ensure that professionals have the essential expertise. Strong technical capability is crucial to success. The strong economic performance of Japanese industry compared with that in the United States in the 1970s is partly due to the relatively large fraction of engineers among production workers in Japan. Similarly, the construction of the Interstate highway system, which has been the paramount achievement of the current generation of state engineers, was done with remarkable efficiency, dedication, and integrity.

Nevertheless, the basic skills that underlie these professional accomplishments--analytical ability, knowledge of physical systems and their properties, communications skills, and creativity--are not necessarily closely correlated with current certification procedures. As a result, non-engineering technicians who have acquired these skills increasingly complain of the lack of opportunity in some state department of transportation, and they question the current relevance of certification procedures that were established in an

PROFESSIONALISM AND REFRESHER PROGRAMS

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The delivery of the refresher course for the professional engineers examination is somewhat more difficult than that for the engineer-in-training since most engineers, who are anticipating employment in areas that require certification, take the engineer-in-training examination while they are still in school. Once the engineer is on the job for a number of years, his need for the refresher course increases and the availability of these refresher courses becomes more difficult.

Again, as mentioned above, if the headquarters or the district is close to an educational institution that offers that refresher, then the problem does not exist. Where there are DOTD districts which are remote from these facilities, then it behooves DOTD to continue to provide the refresher course so that the engineer may become certified.

To meet this need, DOTD should continue to "inventory" the headquarters and districts and determine the need for such a program. If past experience is any indication of the future, there will be a continuing but modest need every year. This need should be met by DOTD convening a review session for the various engineering disciplines in some central location and conducting such a refresher course either with DOTD engineers or with professors from nearby institutions.

The continuing education department at various Louisiana engineering colleges can be used to meet this need.

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CONCLUSIONS

Nationwide, about 41,000 professionals, mostly civil engineers, now work in state departments of transportation. This number will grow modestly in the next decade and thereby create a somewhat greater demand for highway professionals.

The outlook for retirements is important. An average of about 3.1 percent of state highway engineers is projected to retire each year throughout the coming decade. This is far higher than the average of 1.9 percent for civil engineers in general. These high rates of retirement will create serious stress for many state departments of transportation, particularly those that did little or no hiring throughout the 1970s.

There need not be a crisis in the future availability of professional skills if DOTD takes six steps to meet future needs:

(1) Institute The Engineer Resource Development Program to train mid-level management engineers to assume the varied responsibilities of retiring professionals (this may require revision or other procedures, such as relocation assistance, to facilitate the accelerated development of in-house professionals);

(2) Review internal practices to make sure that there is no erosion in professional expertise needed for the growing and complex rehabilitation work and at the same time make full use of necessary skills within the DOTD;

(3) Exploit the potential of computers through greater reliance on computer-aided design and drafting, automated pavement and maintenance management systems, and other improvements;

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(4) Monitor and adjust incentives needed to attract and retain professionals, including recruitment, promotional opportunities, job satisfaction and compensation, training and educational benefits; and increase the versatility and depth of technicians and expand their application to routine tasks.

Specific aspects of the program are now described.

The Engineering Resource Development Program recommended for DOTD engineers begins with the Engineer Rotation Program. The program is designed to help the newly graduated Engineer expand his technical skills through experience in the various sections of DOTD, as well as to develop the graduate's ability to work with and to supervise people.

Another purpose of the program is to develop the graduate's familiarity with DOTD's organization, goals, policies and personnel. The intent of the program is to develop the entry level graduate engineer's talents in all facets of professional, managerial and technical work and responsibilities. The engineer will ideally develop through the recommended programs both a diversity of technical skills and strong managerial abilities necessary to assume and fulfill a responsible and productive DOTD career.

To administer the program, DOTD must establish a Management Rotation Committee. This committee's responsibility will be ensuring that the placement of graduate engineers takes into consideration the relative priorities and personnel needs of the department. The management members on this committee will pro-

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RECOMMENDATIONS

(1) The work included here can be considered as an initial step towards the solution of the problem. The next phase will include the appointment of the training coordinator, expansion of the continuing education program, preparation of material to supplement the on-the-job training component, and any other necessary activities prior to implementation of the program. The final step will be actual implementation of the rotational program.

It is recommended that the next phase be implemented during the May 1989 to May 1990 period.

(2) It is recommended that ERDP be implemented by DOTD

(3) It is recommended that the training coordinator's duties include, as a minimum:

(a) Conducting an orientation program

(b) Coordinating continuing education activities

(c) Coordinating preparation of video tapes

(d) Monitoring an on-the-job rotation training program

(e) Coordinating DOTD engineering recruiting efforts

(f) Coordinating an appraisal program

(g) Coordinating the preparation of an outline for each training step.

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