formulation of motivational strategies, the application of better resource allocation methods, the use of innovative purchasing techniques and better specification writing, better assessment of training needs and effective training programming, and the use of exhaustive equipment management information systems with more analysis performed with the equipment maintenance and operating data to make more informed decisions. However, these skill requirements are generally a mismatch with the skill levels of top managers at state highway agencies. Almost three quarters of all professionals at state highway agencies and most of the top managers are civil engineers.[10] Traditional civil engineering educational programs focus on planning, designing and building of facilities and structures, and not on many of the skills necessary to more effectively manage with fewer resources.

Conclusions

Viewing the human resources involved in equipment maintenance and equipment management at highway agencies at three employee levels, (mechanics/ technicians, shop supervisor/managers and top managers), the likely trends of the 1990s present each level with one or more human resource dilemma. In summary they include:

Mechanics/Technicians. The qualifications necessary to work on new equipment are likely to require significantly different skills than those traditionally possessed by mechanics. Technology change mixed with increased demands for mechanics/technician from related industries are likely to make it more difficult to recruit qualified mechanics.

Shop Supervision and Management. The efficient operation of an equipment maintenance facility will require shop supervisors and shop management that possess administrative/management and analysis skills. Although technical knowledge of the maintenance procedures is generally believed to be essential for shop managers, solid management, and analysis skills have and will become more important knowledge areas.

Top Equipment Managers. Top equipment managers are likely to be faced the problems of providing increased equipment and equipment maintenance productivity with stagnate budgets. As a result, top managers are likely to be faced with obstacles requiring innovative solutions. Obtaining more productivity from equipment and more efficient equipment maintenance are inherently problems requiring an interdisciplinary approach. The need for interdisciplinary approaches is in sharp contrast to the highly engineering dominated ranks of top management at highway agencies.

End Notes

1. The example is taken from M.A.T. Bamford, "The Effect of Technology on Equipment and Equipment Management," presented to the InternationaL American Public Works Conference held in Orlando, Florida, September, 1989.
2. Bamford, p. 2.
3. For Federal Law, see: 40 CFR 80; also, 40 CFR 86.
4. Glenn A. Endicott and Larry Green, "Training Technicians," Equipment Management, March, 1990, pp. 21 - 23.
5. Association of American Railroads, "Railroad Facts: 1988 Edition," Information and Public Affairs Department, Washington, D.C., 1988.
6. Federal Commercial Motor Vehicle Safety Act of 1986 requires that all operators of vehicles with a gross vehicle weight of more than 26,000 pounds or a capacity of 16 or more passengers have a Commercial Drivers License by the summer of 1992.
7. Maze, et. al., "The Changing Role of Freight Transportation and Intermodal Freight," Midwest Transportation Center, Iowa State University, Ames, Iowa, 1990.
8. Francis Fancois, "Panel 1: Transportation Overview," Reported in "Transportation Infrastructure: Panelists Remarks at New Directions in Surface Transportation Seminar," prepared by the U.S. General Accounting Office, Report No. GAO/RCED-90-81B, 1990, pp. 32-37.
9. "Rebuilding the Foundations," Office of Technology Assessment, Congress of the U.S., Washington, D.C., 1990, p.8
10. Transportation Research Board, "Transportation Professionals: Future Needs and Opportunities," Special Report No. 207, Washington, D.C., 1985.

TRAINING OF EQUIPMENT MAINTENANCE PERSONNEL: APPROACHES AND APPLICATION

Robert Samuelson, *Iowa Department of Transportation*

Introduction

As of January 1, 1990, there were more than 112,000 miles of roads and streets in the state of Iowa. Despite being 25th in land area, Iowa has the 7th largest road system in the nation. Jurisdictional responsibility for Iowa's roads is vested in the Iowa Department of Transportation (IDOT), 99 counties, and 956 municipalities. IDOT currently maintains about 10,500 miles with the counties and cities maintaining the remaining.

IDOT is responsible for maintaining the entire primary road system, all state parks and institutional roads, and shares responsibility with the cities for maintaining the primary highways that extend into the

cities for a total of 24,884 lane miles. To accomplish this, the state is divided into six districts with each district divided into four resident maintenance engineer's (RMEs) offices. Each RME office is responsible for three to seven maintenance garages. Most of the garages are independent facilities staffed with a supervisor, one or more mechanics, and enough equipment operators to handle the work load.

In each garage, a supervisor is responsible for all of the equipment in the garage. The mechanics are required to repair and maintain a wide variety of equipment. They do most of the mechanical work for equipment operated from that garage. This includes activities required in the maintenance of:

- Push lawn mowers to large tractor movers;
- Subcompact pickups to eight cubic yard twin screw dump trucks;
- Replacing a hydraulic valve to servicing an electronic changeable message sign; and
- Tail blade to motor grader or erosion dozers.

The central repair shop in Ames has the resources to rebuild and exchange equipment components, such as:

- Hydraulic cylinders and pumps;
- Engines;
- Alternators, and starters; and
- Transmissions.

The field maintenance forces carry a big load. Not only are they responsible for maintaining the highway system, they must keep all of the equipment operational and operate it efficiently and safely.

The local shop mechanic must know if a piece of equipment is working properly or not and if not, what does it need. Anything short of a complete rebuild is done in the field. If the local mechanic feels a complete rebuild is necessary, he can pull the component, send it to the central repair shop in Ames, and exchange it for a previously rebuilt unit. The local mechanic must identify the problem. If it merely needs repairing, he must make the repair. The same is true with equipment operators. The field maintenance forces must choose the right piece of equipment and use it properly. This makes the task easier, more efficient, and produces a better quality product.

The equipment operators and mechanics in Iowa need training to accomplish these tasks. This is accomplished in some states with training academies while other states have many full-time trainers. Some of us have neither.

The lack of a full-time training staff need not prevent us from accomplishing our goals. IDOT accomplishes this by using new technology as it becomes available and utilizing the resources available to make that technology work.

Thirty-five years ago, IDOT had 16 mm films with one projector per district. Films were shown, then IDOT evolved to slide tape programs with one projector per residency. The first slide tapes were developed by a consultant. Several slide tape programs were developed in-house using people who had full-time jobs in other areas, but took time to put the programs together. They were shown to the equipment operator and mechanic with discussions following. When video became available, a consultant was hired to develop programs on equipment operation, preventive maintenance, and safety. Initially, one TV and VCR were purchased per residency. The goal now is one set per garage.

Development of the video program amounted to the preparation of instructors guides, lesson plans, a daily PM checklist, quizzes, operator observation sheets, and training the trainers. Then a team approach was used in presenting programs. The typical presenters included an experienced equipment operator, who was an expert in operating the pieces of equipment being covered by the training, and an experienced mechanic, who understood preventive maintenance of that piece of equipment. This team would take the program into each garage in each residency or district and conduct the training.

The basic approach included an introduction to the program, presentation of videos, demonstrate what they had seen, present additional videos, complete a written test, and discuss the quiz answers. Operators observation sheets were left with the local supervisor for his use in grading each of the crew on how well they retained what had been covered. A successful accomplishment card was then presented to each person who completed training. The effectiveness of these programs increased with strong support from local supervisor and resident engineer. These programs can be developed locally, each district has a camcorder for this very purpose. It is a good way to introduce a crew to a new concept developed in other areas.

Keeping our mechanics up-to-date with changing technology and to new types of equipment and components has always been a problem. Private mechanic schools have been used in the past and mechanics complained because they didn't use the same type of tools. The schools used different types of electronic testing equipment, and worked on different engines and components.

Factory trainers, such as engine manufacturers, transmission representatives and brake system representative, have also been tried. These people brought their training aides with them, set them up in the shops, and taught the mechanics. This was valuable, but there was not enough hands-on experience. In-house training has also been tried. Trainers were not available to teach the best mechanics how to be good trainers. Videos were purchased to be used on VCRs in the shops, but this was not the total answer.

For years mechanics have been reimbursed for registration and books if they attend night school classes at local area colleges on their own time. Few took advantage of this, possibly because much of the training did not apply directly. Mechanics are encouraged to attend training put on at local parts houses with the factory instruction concerning their product line.

Training with the Des Moines Area Community College

The Des Moines Area Community College (DMACC) has an auto mechanic course. This is a publicly supported two-year college. It is one of sixteen such schools in Iowa. These schools were established by the legislature in 1966. Their purpose was to meet the community interests, students abilities, and personal objectives of the citizens of all ages and levels of education. In the fall of 1985, the Economic Development group of DMACC was contacted to develop a training program where the mechanics could improve their job skills. The objective was to develop an annual one-week course, progressive in nature with repeats for the new mechanics.

A great need was with the diesel engines. Based on years of experience, the mechanics had learned gas engine but were struggling with diesel. DMACC met with the six district mechanics to learn first hand their specific needs. Everything in diesel mechanics could not be taught in one week. It was decided that the course would address basic diesel fuel system and diagnosis. A 32-hour basic course on diesel engines and fuel systems including disassembly and testing of parts was developed.

IDOT trucks were provided with diesel engines that could be disassembled and reassembled by the students. The students brought their own tools. The field mechanics desire to work on the same engines that they work on daily with their own tools. Sophisticated electronic testing equipment, that the mechanic did not have access to in his own shop, would not be used.

The course was designed to have a minimum classroom lecture time with a maximum hands-on experience in the shop. The course cost $3,220 to develop and $1,372 to conduct per 32 contact hours with a maximum of 15 students. One of the IDOTs district mechanics was present during each class to assist the instructor as needed and to handle policy questions. After the class instructional outlines were prepared, the district mechanic reviewed them and suggested changes. The course was a success beyond all expectations. This was due to the type of training--it was hands-on, and well presented.

The training was presented by an instructor who had years of experience in diesel engine repair before becoming an instructor at DMACC. Every questions or problem a student raised, the instructor could answer based on experience, not book knowledge. This is the type of training that can be obtained through community colleges in other areas. It is the type of training that fits the IDOTs needs. IDOT does not have a large training staff to develop programs. There is no time in the office staff's work schedule to dedicate to training activities. All the meetings with the district mechanics and the area college people were held at the regularly scheduled by-monthly meetings of the district mechanics. The shop meetings did not involve management except to set them up.

The district mechanics did have extra work in scheduling their mechanics to the schools and in being present to take their turn to help the instructor. Some attended two schools, meaning two total weeks of commitment. What the mechanics learned has reduced the workload on the district mechanics because they are now able to perform their work with less help from the district mechanics.

The first class was held in 1986. In 1987, the class was on Advanced Diesel System Training. This included 32-hours of continuation of the basic course and covered diesel engine performance problems and tune-up procedures. In 1988, the 32-hour class was on Automotive and Heavy Duty Electronics. This covered basic electrical theory and diagnostics of electrical problems on light and heavy duty vehicles. The course included an introduction to computerized electronic engine controls. In 1989, the 32-hour course addressed Diesel Engine Theory and Diagnosis. This course was given to new mechanics that had not had the previous two courses, to bring them up to the level of training that the other mechanics had received. An additional course was given in 1989 on Mobile Hydraulic Training. This covered basic hydraulic theory and the IDOT snow removal truck hydraulic system design and diagnosis. IDOT made a furnished cutaways of hydraulic parts and components of actual units. Detailed hydraulic schematic drawings of the hydraulic systems were also developed for the student manuals. In 1990, the course will address Brakes

and Brake Systems. Again, IDOT will assist by providing trucks and components for laboratory use.

Each course had the series of meetings with staff and mechanics and each course was redesigned during the first session with good report coming from all attendees. Each course was followed by a review of the just completed course and plans for the next one. Tests and student evaluations given before and after some of the early courses helped to identify the effectiveness of the training and future training needs. One of the early decision had to be how to divide the classes: by experience level of the mechanics; by district - all one district at a time; or mix them all up.

DMACC suggested that the classes be mixed. There was some hesitation to categorizing the mechanics skills. They didn't want to hurt anyone's feelings. The more experienced could help lead the less experienced. Discussions before, during and in the evenings are also a learning experience. Getting to know other mechanics from other parts of the state is also good.

The area college staff was professional in working with classes of varying degrees of expertise in the subject and a wide range in ages. This is typical of their classes. To smooth out some of the range in knowledge before the next class, all mechanics will be given an opportunity to take the AASHTO course on Brake Systems before their attending this year's brake course at DMACC. The DMACC instructor is also viewing the tape and reviewing the materials so he will know what has been covered before he starts his class. The AASHTO course is basic for our mechanics. It cannot replace the DMACC training, but it will supplement it.

Electronic Time and Attendance Reporting

Last winter, we expanded the college program to computer operator training. IDOT is transitioning to electronic time and attendance reporting, and soon hope to have a crew day card reporting system with a central office mainframe connected PC in each maintenance garage.

The course was developed using the same basic approach. In this case, the instructor spent several days in the IDOTs office:

- Learning programs and program applications;
- Using machines to work programs;
- Taking notes to develop a teaching and student notebook; and
- Making screen prints to include in the notebook.

Meetings were held with a sample group of people that would be taking the course to see how the instructor perceived their needs. The instructor and staff coordinator asked questions, and listened to answers and comments.

The course was held in the area college classroom, but used IDOT computers connected to the mainframe so the course would be taught on the identical machines used in the field. Students spent four days working on the computer programs--the same programs that they have available to them in the field offices and on the same machines. They returned home with a notebook with screen prints and complete instructions on each program. The success of the class was so great that the three scheduled classes had to be expanded to five to handle the number of students. Many good comments were received from the field. Two comments stand out. First, one student reported she had never been in a class that did not leave someone behind or bored. This was not the case in this course. Everyone felt they were learning together though some were much more experienced then others. A second comment came from an in-house resource person who helped develop the first class and encourage its development because she was unable to handle this size of a project with the time constraints. She commented after the first class that she had never seen a class become so interactive. They were like one family of students helping each other. Instructor providing the guidance and the students assisting the instructor as they worked through the programs.

Commercial Drivers Licenses

The newest project, with the area college, is to provide training to assist equipment operators in obtaining the new commercial drivers licenses. DMACC has developed a one-day (8 hour) course to meet this need. It will be taken to the field and presented just before taking the test for the new license. Again, the course was developed for the IDOTs specific needs. IDOT trucks will be used for the pre-trip inspection. DMACC has reformatted the commercial driver license manual to better fit their training course. They have developed short quizzes at frequent intervals in the course to test the progress of the class and to reinforce important points. The course has been piloted and found to be very good. The estimated cost will be about $60 per person for the full day course.

This type of training has worked in Iowa. The area college has solved a need. This success is because

- The area colleges in Iowa train rather than teach;
- They don't just tell you how, they show you how;
- Instructors are experienced practitioners of the trade not textbook learners;
- They use the IDOTs equipment; and
- They used our tools and programs.

Management also learned from these courses. The instructor in the mechanics schools identified some tools that could be added to the inventory to help the mechanics do their job. IDOT furnishes the mechanics with all the tools they need. The new tools were not expensive, but they were tools that the instructor had found by experience to be useful.

In summary, IDOT uses a wide variety of training aids. The area college is quickly becoming a very important part of the training program. It is a resource that should not be overlooked by anyone with training needs.

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION MECHANIC APPRENTICESHIP PROGRAM

John Burns, *North Carolina Department of Transportation*

The increased use of on-board electronic control devices and their related systems presents a challenge to every equipment operation. To keep NCDOTs work force at current manning levels with well-trained input, we have established an apprenticeship program certified by the North Carolina Department of Labor (NCDOL) and the U.S. Department of Labor (USDOL).

Apprenticeship establishes a formal training program that, through classroom training and on the job training (OJT) under the supervision of a journeyman mechanic, produces an individual at the journeyman level, trained according to our unique job requirements. Though certified by NCDOL, local program control is designed to require 3-1/2 years for completion.

The first step is to establish standards of apprenticeship. The proposed program includes, as a minimum:

- The work process or OJT description;
- Formal instruction identification and schedule; and
- A wage schedule.

The work process includes the plan for hours an apprentice will spend while obtaining OJT. Areas of OJT are broken down into engine overhaul, light equipment, truck, welding and various component rebuilding. Apprentices rotate through assignments, one per area on a 6 month cycle. Supervisors are urged to ensure meaningful job assignments that will benefit the apprentice and provide increased shop productivity.

Related classroom training describes a minimum of 144 hours of instruction per year for certification. This can be provided by a community college, manufacturer or the DOT training department. Our schedule currently requires 272 hours of instruction per year. Along with scheduled technical courses, we have included math, first responder first aid, oral and written communications and human relations.

A spinoff advantage to the apprentice training program is the opportunity it provides for field and depot mechanics to attend the same classes. In the technical college system, course expenses rarely exceed $35.00 per student. Courses provided by the industry may be no cost, if local, or require only travel and per diem expense.

Our training coordinator works closely with community colleges in designing courses and selecting instructors. Classes range from 40 to 80 hours in length. The NCDOL requires that apprentices receive compensation of at least 50 percent of a journeyman mechanic. They desire that apprentices receive a pay raise every six months if progressing satisfactorily. The sponsor must appoint a six (6) member committee and one (1) supervisor of apprentices to handle day to day program management. The Supervisor of Apprentices assists the committee in administering the program including being responsible for records and serving as guidance counselor for apprentices. NCDOTs program is off to a good start. We expect to expand to include traffic services signal technicians and other shop trades soon.

Retention of apprentices is a concern. All successful apprentices will be offered positions as they become available. The length of the program serves to promote retention with 3-1/2 years toward retirement, the accumulated sick leave, annual leave and additional benefits recognized as reasons for remaining with the DOT. NCDOT was surprised at the number and quality of applicants. Most came from students graduating from high school and technical college vocational programs. Individuals leaving the armed forces also provide motivated candidates.