they all agreed to implement all six programs by December 30, 1983.

These assignments and deadlines were put in writing to them so that their tasks and deadlines were clear. All six programs were written and implemented by the deadline of December 30, 1983.

At this point, we ran into a bit of a delay in that NYSDOT as a whole had not stood still concerning microcomputers. There was great interest in micros by other program areas and several different micros were being acquired by different programs. This forced our administrative staff, who have overall responsibility for computer support, to insist on a common operating system for micros to facilitate the exchange of computerized information. They decided on the MS/DOS operating system, which runs the IBM PC and several other makes. Up to that point all the committee's work had been based on the CP/M operating system.

Therefore, the committee had to convert the software they had developed and acquire hardware that could use the MS/DOS operating system. The committee decided to use a new microcomputer on the market, the Tandy TRS-80, Model 2000. This machine uses the required MS/DOS operating system and is a faster machine than the older Model 12. At the same time, it was decided to adopt a new printer, the Okidata Microline, Model 93P.

The committee modified their programs so they could be used with the Tandy TRS-80 and eight useful menu driven programs have been developed for direct application at residency level. Six more are being developed.

One example of a useful program is the payroll change program. Our payroll system is set up to print out the same checks to the same people unless it is instructed to change. The residency is responsible for initiating changes for their staff; this is a large, repetitious, and tedious task, especially in the winter when all of the blue-collar employees are earning overtime on snow and ice control. It was common for residency clerks to spend 15 man-hours per biweekly pay period on this task. With the micro, this work is reduced to 1 man-hour. We feel this one program application will pay back the cost of the hardware in a year.

The committee's work showed that micros can be used successfully at the residency level, so successfully, that once installed, they become almost indispensible. Consequently, we plan to install micros in 38 residencies this year and the remainder in 1985.

In summary, we have been successful by following the procedure of defining possible applications, finding software that should do the job, and then matching hardware to the software.

We were also successful because the users developed the programs to meet their needs; nothing was imposed from above. We were fortunate in having intelligent, technically trained, enthusiastic users, who had the capability of effectively putting micros to work.

In closing, I would like to give credit to the members of the committee. They are

David Palma, Saratoga residency;
Richard Bassler, Cortland residency;
Fred Ames, Steuben-Chemung residency;
Chet Moody, Cattaraugus residency;
Albert DiCesare, Niagara residency; and
William Dixon, main office.

Merging Construction and Maintenance Activities in South Dakota

WILLIAM M. GERE

South Dakota is responsible for maintaining some 18,500 single-lane miles of highway and administering the activities of contractors on an average of 250 construction projects annually.

In the fall of 1980 because of continued pressure to reduce the number of department employees, it became obvious that we were going to have to reorganize to provide adequately staffed and trained construction inspection and maintenance crews to handle the work assignments.

We reviewed the last 8 to 10 years of our maintenance activities and determined that we were adequately staffed in the rural areas at the rate of 20 two-lane miles per maintenance worker including a foreman and 15 two-lane miles per worker in urban areas. The construction inspection and engineering staff need was being planned by a construction engineering management system that had been initiated in 1979 and a 5-year construction program that we were reasonably comfortable with.

The South Dakota Department of Highways was established in the late 1930s. It was organized into five districts with a district engineer in charge of each district, and the mileage assignment among the districts was reasonably equitable. In 1974 the South Dakota Department of Transportation was created.

As a general rule the maintenance work was assigned on a county basis with at least one maintenance crew with a foreman in charge in each county. In some of the more densely populated counties with a greater number of miles of road there were two or three maintenance crews.

Construction engineering and inspection was assigned to an individual identified as the resident engineer with a crew of professionals and subprofessionals varying in number depending on the amount of work. In the early 1950s we had 30 to 35 of these residencies looking after construction work and 90 to 100 maintenance crews. With the advent of Inter-

state highway construction, construction engineering unit staffs were increased substantially; and by 1969 our field staff numbered 1,100 people. This included the engineering construction crews, the maintenance crews, and administrative and support staff for the five district headquarters.

In 1961 the district engineer in concert with the central office management decided that there was a need for another level of supervision in the field headquarters office; this was provided by appointing two assistant district engineers, one in charge of construction and the other in charge of maintenance. This was our organization until 1980. An increasing awareness that construction activities would have to be curtailed because of dollar inflation made it necessary for us to assess the efficiency of the existing organization. A full-time equivalent ceiling, imposed by the budget, required a change that would allow placement of construction or maintenance personnel at a project site.

We started at the top in the central office merging functions and reassigning supervision. The central office staff administering the construction and maintenance programs, which had been two separate offices for many years, was merged into one Operations Support Office with one engineer in charge of both construction and maintenance. Along with the personnel from the former maintenance and construction offices, other personnel from property management, traffic operations, billboard control, labor compliance, utility, and railroad operations were transferred into this office. The result was that the total department staff was reduced by 10 to 12 full-time employees.

At this time we transferred some of the responsibility that had been in the construction office to the field offices (e.g., construction change orders, price adjustments, and claims). District engineers (later region managers) were given the responsibility for administering these requests without central office approval. Some apprehension went along with this reassignment of responsibility but after 3 years of operating in this fashion it is working satisfactorily.

A vacant assistant district engineer position was created in making the changes. Instead of appointing someone to fill that position, we looked at some of the other states and decided to merge construction and maintenance activities in that district.

We organized that district into three separate areas with an area engineer, who is responsible directly to the district engineer, in charge of each. The maintenance units and construction crews were made directly responsible to the area engineer. Some of the resident engineers were reidentified as project engineers. Each one is in charge of one or more construction projects and is responsible directly to the area engineer.

The same thing was done with the maintenance foreman. The field management organization now has four levels: district engineer, area engineer, project engineer or foreman, and construction technician or maintenance worker. The previous assistant district engineer and resident engineer or maintenance superintendent positions were abolished, eliminating two levels of authority.

We operated in this way until the spring of 1983 with one of the five districts organized into three areas and the other four districts still operating with both a district engineer and an assistant district engineer. Observation of the area concept with a reduced supervisory staff indicated that district was functioning as well as the other four. We were encouraging all of the field districts to reassign both maintenance workers and construction technicians to the greatest degree possible to give them an opportunity to learn each other's trades and skills, especially for supplementing each other's units as seasonal personnel shortages occurred. There was some resistance to this melding together of maintenance worker and highway technician assignments; however, an increased awareness of the benefit in doing this developed as time passed and more multiple work assignment activity was under way.

Late in 1982 a new secretary took charge of the department. His first message was that there would be a substantial reorganization. At this same time the passage of the 1982 Surface Transportation Assistance Act seemed imminent, and thus we were faced with an increase in construction, whereas 2 years before a decrease had been expected.

The first 6 months of 1983 were spent in brainstorming and putting together a reorganized department plan that completely eliminated one of five district headquarters. In the new department organization that was implemented on July 1, 1983, the field units were organized into four regions with a region manager in charge of each.

All four regions were organized into three areas as the experimental district had been in 1980 with an area engineer responsible directly to the region manager and the project engineers and the maintenance foreman responsible directly to the area engineers. Closing the district office created a surplus of 35 to 40 personnel. All of these people were offered opportunities to transfer to other parts of the state, but by and large they elected not to move. A number of them took early retirement and others found different employment.

In 1972 we had started to eliminate those field maintenance units with low mileage. This was based on the decision that there was no operational or economical benefit in trying to operate maintenance crews responsible for fewer than 100 two-lane miles. Units were closed as personnel retired and equipment wore out. By 1983 14 units remained in the elimination plan. The July 1, 1983, reorganization addressed this plan immediately. Notice was sent to each unit with a limited mileage responsibility that it was being closed and its responsibility transferred to neighboring units. This was done with some amount of complaint from local communities and some objection on the part of the maintenance workers; however the closures were accomplished by year's end and the surplus property and equipment was disposed of.

The construction engineering stations that were not located at the 12 area headquarters were also put on a list for elimination. There are 10 of these engineering stations, 4 of which will be closed by January 1985. The others are scheduled for closing as the construction work in their area is completed or at least reduced. With the current construction program and assuming that increased funding will continue, it appears that it will be near the end of the decade before these engineering stations are closed.

On July 1, 1984, the department will have a field staff of 930 people (down from 1,100 in 1969). This includes the four region headquarters and their administrative and operations staff, the 12 areas with their construction engineering crews, and 75 maintenance units. The maintenance units are organized into crews of from 5 to 10 people charged with the responsibility of looking after from 100 to 200 two-lane miles of highway.

With the reduced staff of field personnel and a highway system that requires as much if not more maintenance attention than when the staff was larger and an increasing construction program, the department found itself in a bind. There were two obvious courses of action: (a) some of the maintenance work

and the construction inspections could be neglected, which is not a viable alternative, or (b) some of the work could be done by contract.

For a number of years now the department has been contracting 25 to 30 percent of its maintenance needs, and we are going to have to continue at that level or higher. Also, agreements are being drawn up with consulting engineers to do construction inspections. Other tasks that could be done by contract include material testing, plant inspection, grading inspection, surveying, and it is possible that we will hire a consultant to look after an entire construction project.

I had hoped to report a complete reclassification and merging of the highway maintenance worker and construction technician grades into a new position description combining the knowledge, skill, and ability required for both job assignments. Although this is being done, it has not been completed. As previously indicated, work assignments frequently cross between maintenance and construction, and I am sure that all of the employees understand this to be our goal.

The area organization, with its reduction in middle management supervision, is functioning better than I anticipated and appears to be enjoying good acceptance.

A Maintenance Management System for Road Markings

PER SIMONSEN

The Danish Road Directorate has recently issued provisional specifications for marking traffic lanes of main roads beginning in 1984. Simultaneously recommendations on materials for, and maintenance of, marking were issued. Specifications and maintenance strategy are based exclusively on the functional requirements of the markings. It is to be expected that the introduction of the recommendations will result in a higher standard of marking and thus contribute to increased road safety.

GENERAL SPECIFICATIONS FOR MATERIALS AND EXECUTION

Marking performed by contractors is required to meet a number of conditions [referred to in Denmark as the AAB (1,2)] before delivery and before the expiration of the guarantee period. These fall into three general categories: (a) optical properties, (b) skid resistance, and (c) durability. The required minimum values are stated in Table 1.

Optical Properties

A recently developed reflectoscope (i.e., a small box with white opal glass plates) is used for measuring optical properties (see Figure 1). The measurement is made by comparing the road line with a number of filters placed in front of the opal glass plate.

For unlighted roads, the reflection of the road marking in the dark, which is indicated by the specific luminance (SL), is determined in the light of the main beams of the headlights of an automobile. The reflectoscope is placed behind the road marking with the measuring face turned toward the spot of observation, which is chosen to be about 50 m in front of the reflectoscope at a height of 1.2 to 1.5 m above the carriageway (see Figure 2). The reflection is determined by comparing the road marking with the different reference surfaces.

For lighted roads and in daylight the reflection properties of the carriageway markings are deter-

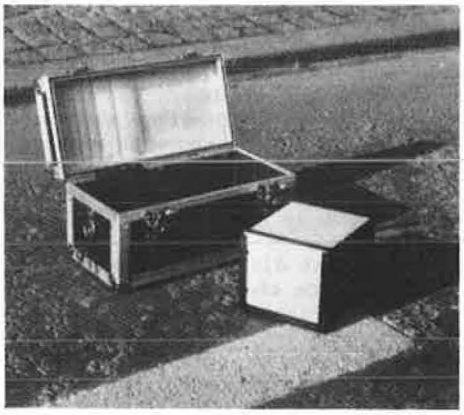

FIGURE 1 Reflectoscope with storage box and filters.

TABLE 1 Functional Requirements for Road Markings

Time	Mean Luminance Coefficient, Qo ($cd/m^2/lx$)	Specific Luminance, SL ($cd/m^2/lx$)	Skid Resistance (srt)	Maximum Wearing (% of area)
At delivery	0.16	0.16	55	0
Expiration of guarantee period	0.13	0.13	55	30