Potential Supply of Manpower for an Expanded Secondary Road Program

JOHN E. STONER, Professor of Government
Indiana University

The present and potential demand for technical and engineering assistance in secondary road administration was surveyed by a questionnaire circulated to executive road officials in each of the 87 counties of Minnesota and to 182 selected officials in 36 other states. Names in the latter group were taken from among those who have participated in the Forum of the Better Roads Magazine.

This problem is apparently of vital interest to county road men. Eighty of the 87 county highway engineers in Minnesota (91. 9 percent) and 118 of 182 in the other states (64. 8 percent) filled out and returned the questionnaires.

It is the opinion of these county men that:

1. The need for the largest numbers of engineering assistants in an expanded program will be for subprofessional personnel (rodmen, chainmen, draftsmen, and instrument men). These persons can be secured and trained by the counties, even if the present road program is expanded 100 percent. Not all counties can do this, whereas others can secure and train more than will be required.

2. The need for registered professional engineers will increase about 57 percent if the road program is expanded 100 percent. For example, 80 engineers in Minnesota estimated the need to be for 46 more engineers for a 100 percent expanded program. And these 80 men have had 42 assistants who have become county highway engineers.

The first requirement points to a need for coordinating distribution and promotion of subprofessional personnel across both county and state lines.

The second requirement points to the need for closer cooperation between the state and local highway administrations in the handling of professional personnel. If there were close cooperation between local and state road jurisdictions and among the various states, subprofessional personnel could start wherever jobs became available. As they learned through practice, they could expect to move to jobs requiring a greater degree of knowledge. Further, they could be expected to enter engineering schools either for full-time training or on a cooperative basis. Such a system would seem to hold genuine promise for an adequate supply of high type professional personnel.

● IN an expanding economy which is being leavened by increased scientific knowledge and mechanized by a constantly developing technology, the vital question is and will continue to be: Are there enough men being trained to replace specialists who now operate the whole material portion of our society? These men, like all others, find other jobs, lose interest, grow old, and substitutes must be ready on the bench or warming up to take their places if the game is to go on.

The problem of the supply of engineering and technical know-how at the local road administration level is particularly pressing at this moment for several reasons. (1) Since the coming of the automobile it has become necessary to add scientific knowledge to common-sense knowledge in order to build roads for present-day traffic. State highway departments as a rule have acquired this scientific knowledge. However, many county administrations do not yet have the every-day use of engineering know-how. This implies that more engineers must be trained if local roads are to be built as well as we know how to build them. (2) Sufficient men must be trained to replace those already growing old in the service of local road administrations. (3) If already existing needs for engineering personnel as well as needs for expanded local road programs are to be met, larger numbers of professional and technical personnel will be required.

A survey of the amount of professional and technical know-how in local administration

and of the opinion of the road men as to potential needs was made by questionnaires.

Questionnaires were sent to all of the county highway engineers in Minnesota by a member of their professional association.[1] And to get some picture of the situation elsewhere, a more general sample was obtained by sending the questionnaires to 182[2] county highway engineers in 36 other states. The names of these men were taken from among those who have participated in the Forum of Better Roads.[3]

The results of these questionnaires are not necessarily representative of the whole country. Only 269 local road jurisdictions out of a total of more than 3,000 in the United States were covered. The men answering the questions probably are among the leaders in the local road field. While it is true that all the county men in Minnesota were covered, it also is generally recognized that Minnesota county highway men as a group are outstanding.

The response to the questionnaires was extraordinary. It suggests that these men feel the questions deal with a vital set of problems. Out of a total of 269 questionnaires distributed, 199 (73.97 percent) were returned. The number and percentage of returns for the two groups are shown in Table 1.

TABLE 1

	No. of Questionnaires Sent Out	No. of Questionnaires Returned	Percent Returned
Minnesota	87	80	91.95
Selected States	182	119	65.38

The questionnaire sent to the selected states differed slightly from that sent to the Minnesota men. Anyone who has engaged in research of this type involving tall stacks of questionnaires and seemingly endless columns of figures and tabulations knows the problems which crop up in analysis. Did everyone interpret the question in the same way? Is each answer the result of equally mature deliberation? And I am certain, too, that no one completes a study of this type without thinking of the old definition of a statistician as the man who drowned while crossing a pond with an average depth of eighteen inches.

This engineering survey is only a sample, and the findings should be labelled both "tentative" and "preliminary," but they do provide the beginnings of answers to some basic questions.

A primary question is: Can the road industry depend upon the present top-level local road men remaining on the job, or are they eager to find other employment? Two important facets of the answer to this question were brought to light by the questionnaires: (1) County highway engineers apparently plan to work as long as they are physically able. (2) The young county engineers are not being syphoned off.

A correlation of the engineers' completed service and intended service (see Figures 1 and 2) indicate almost to the man an expected career-span of at least 15 plus years. In Minnesota, only one man (60 answering the question) and two in the selected states (77 answering) who have been at the job less than fifteen years plan to quit in the next two years.

Although a considerable number of men (50) plan to retire in the next five years, three-fifths of these (30) have served already more than 20 years (see Figure 3).

It is quite common to find engineers with more than 20 years service in their jobs. For example, 24 of the 79 county highway engineers replying from Minnesota said they had served 20 or more years, and there were 36 of the 103 replying from the selected states in the same category. All of these facts emphasize the extensive amount of practical know-how and experience which is being accumulated at the local level. This facilitates good road administration because if good men are recruited initially, the longer they serve the greater the volume of know-how.

The replacement rate of present county highway engineers both for Minnesota and the selected states is shown in Figure 3. Of the engineers now serving, roughly ⅓ of those

[1] This questionnaire with a summary of the answers is in the Appendix.

[2] The executive official in the local road jurisdiction has been called county highway engineer in this paper for reasons of convenience regardless of his title and of the name of the jurisdiction.

[3] This questionnaire with a summary of the answers is in the Appendix.

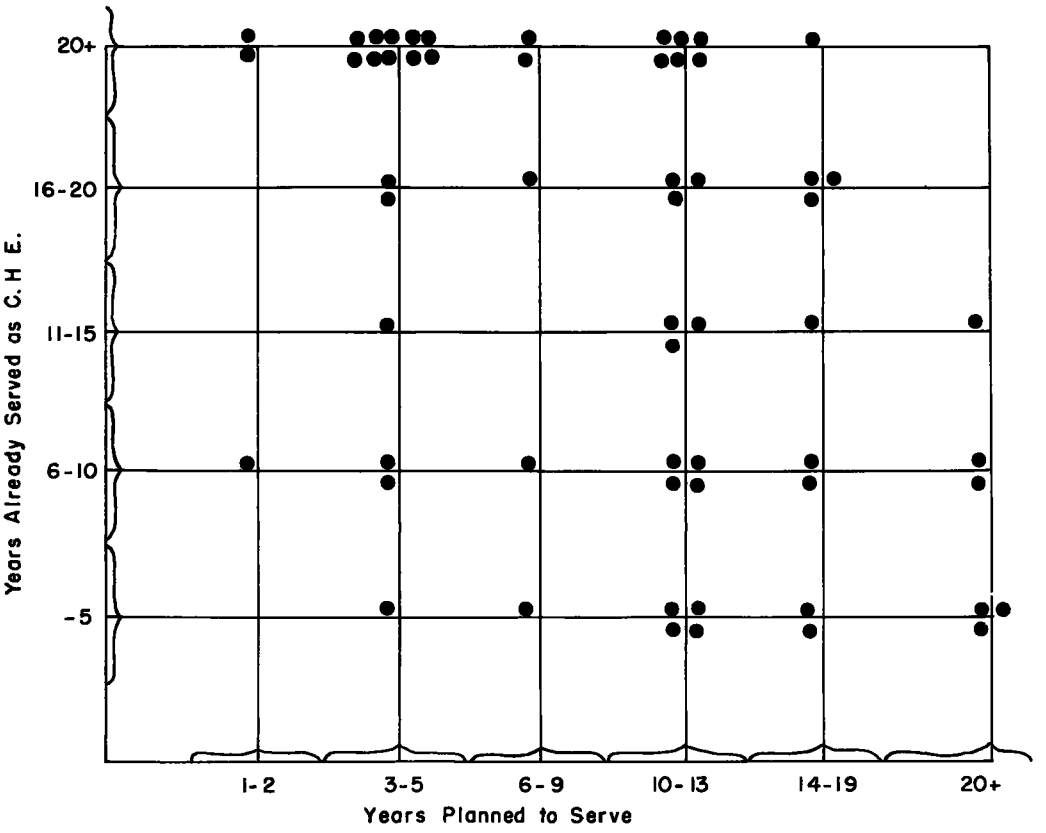

Figure 1. Relation between years of service and anticipated future service of county highway engineers, 59 county highway engineers in Minnesota reporting.

in Minnesota and $^2/_5$ of those in the selected states must be replaced by the end of five years.

The next question is: Will men be available to fill these places? Two sources of supply are possible. (1) Men may come from outside of present local road employment. Such sources are engineering schools, private employment, including engineering and consultant firms, contractors, state highway departments, etc. In some states the state highway department is an important source of supply for county highway engineers. For example, in Minnesota two out of three of one large group[4] were formerly employed by the state highway department. (2) Men now employed in the local road jurisdictions constitute the second source. The questionnaires were designed to throw light on the number of men now in local road employment who could be expected to move into the positions of top responsibility.

There are 55 assistant engineers in Minnesota; 42 of them are below 50 years of age. Minnesota will need only 18 county highway engineers during the next five years to replace those now in service. Thus we have more than enough technically qualified men to fill anticipated vacancies in that state. In the selected states the potential supply of engineers while adequate is not so great; 32 vacancies are to be anticipated in the next five years and there are 46 assistant engineers under the age of 50.

While the assistant engineers do not represent the only source from which county engineers may come, it appears this source alone may contain an adequate number.

The number of assistant engineers whose ages are known, their age distribution and

[4] Sixty-six men were in this group.

their professional status is shown by Table 2.

In addition to the assistant engineers, present county highway departments have many additional personnel who are an important source of persons to move up the technical and professional ladder.

In order to determine the present condition of county highway department staffs, as far as personnel is available for promotion or training for promotion is concerned, a detailed review of the existing staffs was made. It was geared to the years the county highway engineers intended to retire to give a sharper picture of need and how it may be met.

Tables 3 and 4 indicate that present engineering resources are sufficient to meet top-level replacements over a considerable period, and that there is personnel suitable for additional training to bring staffs up to adequate standards for present program needs. For example, over a period of 21 years and more (see Table 3) Minnesota engineers indicated retirement intentions. The pool of potential engineering resources on present staffs to fill these 60 positions and others which will become vacant because of movement upward consists of: 42 assistant engineers, and a total of 172 engineering assistants. Among these are 48 engineering assistants who are either registered or are qualifying themselves for registration and 108 additional engineering assistants who can set grade lines and figure quantities. Also among these are 26 graduates of engineering schools, 13 college-trained men and 56 engineering assistants with the executive ability necessary to fill the position of county highway engineer.

Additional Minnesota potential is now available in the highway department staffs which was not included in Table 3 because the engineers did not indicate intended retirement

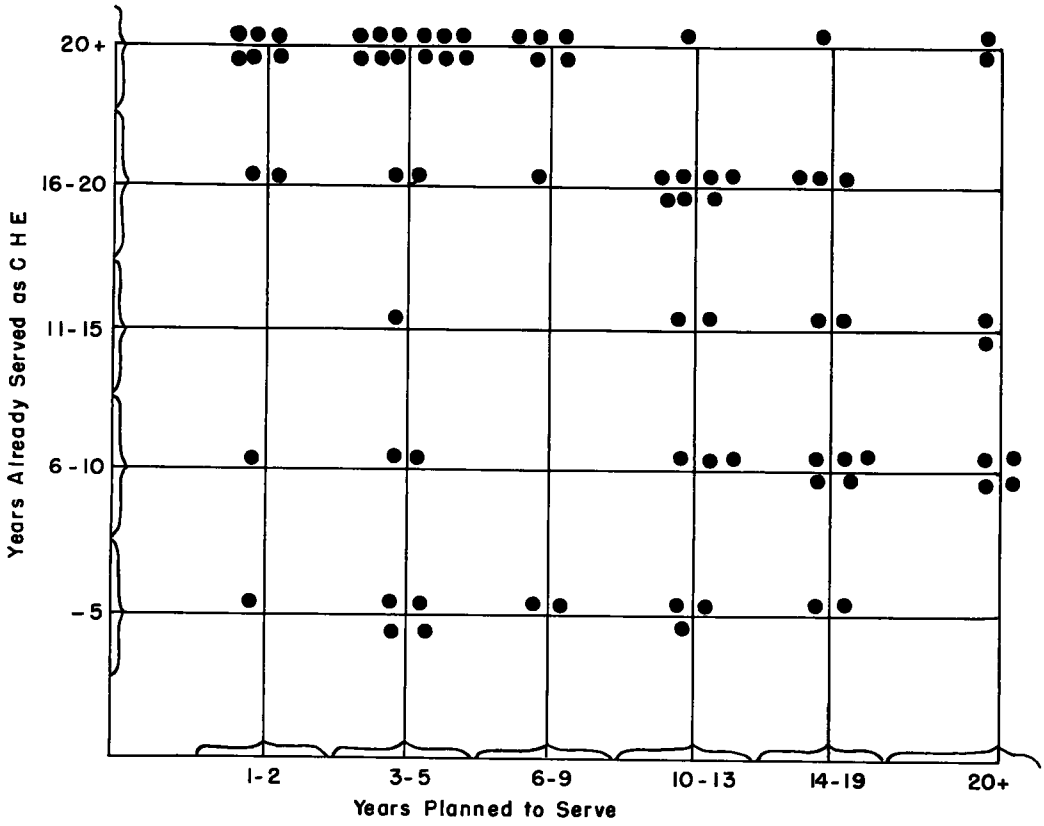

Figure 2. Relation between years of service and anticipated future service of county highway engineers, 77 county highway engineers in selected states reporting.

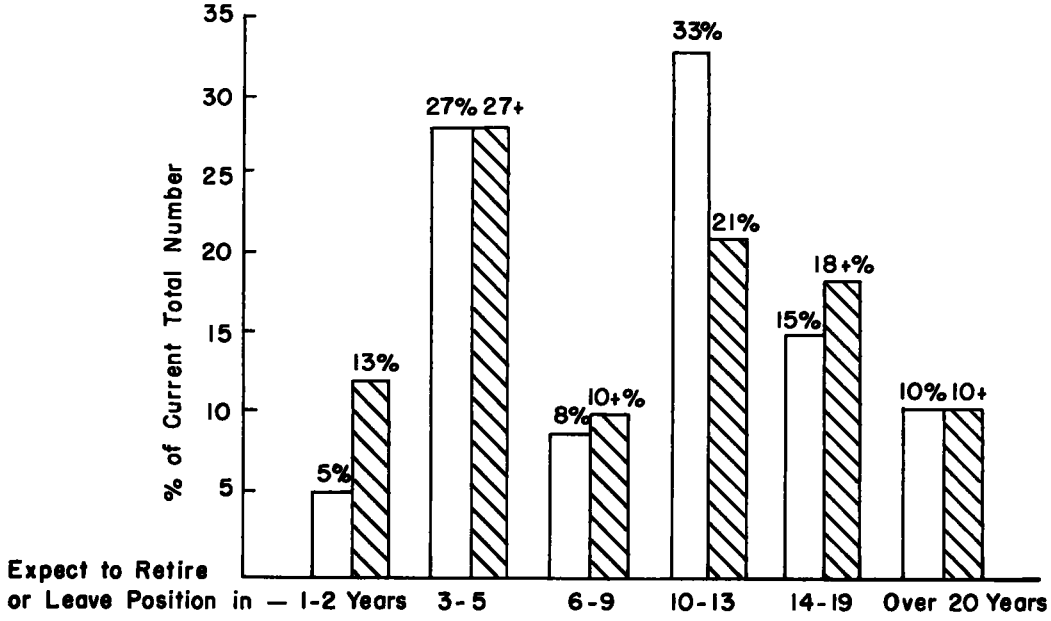

Figure 3. Potential replacement needs for present Minnesota and selected states - county highway engineers.

Note: This figure is based on the question - "How many years do you plan to continue as a county highway engineer?" 60 out of 80 or 75.0 percent of the Minnesota CHE's returning the questionnaire replied to this question. 77 out of 111 or 69.36 percent of the selected states CHE's returning the questionnaire replied to this question. Percentages are corrected to the nearest whole number; fractions under .5 are indicated by a (+).

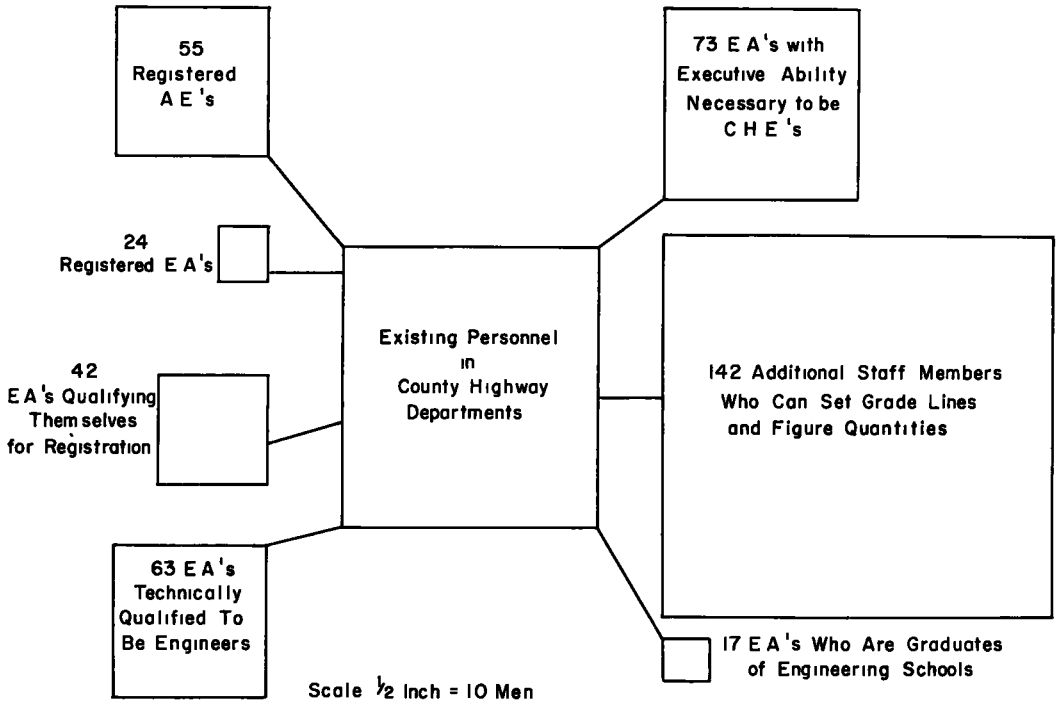

Figure 4. Potentials for professional staff replacement and expansion in Minnesota.

TABLE 2

AGES OF ASSISTANT ENGINEERS IN MINNESOTA[a] AND SELECTED STATES[b]

	Minnesota	Selected States
21-24 years	1	2
25-29 years	6	9
30-34 years	9	11
35-39 years	6	2
40-44 years	10	8
45-49 years	10	14
50 and above	9	28
	22 are below 40 years	24 are below 40 years
	29 are above 40 years	50 are above 40 years

[a] 55 or 70.5 percent of the CHE's replying to the questionnaire have AE's. Minnesota requires AE's to be registered.

[b] 78 or 73.58 percent of the CHE's replying to the questionnaire have AE's. 39.74 of those AE's are registered. Difference between number of AE's and total number for whom ages of AE's are arrayed results from fact that all CHE's did not indicate age of their AE.

dates. The potential on their staffs plus that already set forth in Table 4 is pictured in Figure 4. This figure reveals a surprising strength in Minnesota engineering manpower.

Comparable information on technical and professional resources to fill county engineer and other staff vacancies in the selected states for the twenty-one-year-plus anticipated retirement schedule shows that (see Table 4): there are 56 assistant engineers of whom 20 are registered, [5] and a total of 240 engineering assistants of whom 73 are registered or are qualifying themselves for registration, and 129 additional engineering assistants who can set grade lines and figure quantities; also among these are 52 engineering assistants who are graduates of engineering schools, 87 college trained men, and 63 with the executive ability necessary to by county highway engineers.

Although these tables and figures show a great deal of engineering talent, more than 50 percent of the Minnesota men and 72 percent of the men in the selected states indicated they would employ more engineering assistance if it were now available.

TABLE 3

A DESCRIPTION OF COUNTY HIGHWAY DEPARTMENT STAFFS

Minnesota Counties - 60 Answering

No of CHE's Needed in		Has AE	Hasn't AE	No of EA's on staff	No of CHE's with EA's reg. or qualifying	No. of such EA's	CHE's with EA's who are grads of eng schools	No. of grads	CHE's with EA's who are college trained	No of college trained	No of CHE's with EA's having ability to be CHE	No of these EA's	CHE's with add'nal personnel who can set grade	No. of such personnel
1 year	2	2	0	2	1	1	1	1	0	0	2	2	2	3
2 years	1	1	0	1	0	0	0	0	0	0	1	1	0	0
3 years	4	4	0	7	3	3	0	0	0	0	3	4	3	6
4 years	4	3	1	14	2	2	1	1	1	1	4	4	3	8
5 years	8	3	5	12	5	5	3	3	0	0	6	8	6	13
6 years	1	1	0	2	1	1	0	0	0	0	1	1	0	0
7 years	1	1	0	2	1	1	0	0	0	0	0	0	0	0
8 years	3	2	1	5	1	2	2	3	1	1	2	3	2	3
9 years	0	0	0	0	-	0	-	-	-	-	-	-	-	-
10-13 years	21	15	6	78	13	26	4	14	3	9	15	22	16	52
14-17 years	7	5	2	31	3	3	2	2	1	1	5	6	6	15
18-21 years	7	5	2	17	4	4	2	2	1	1	5	5	7	8
Over 21 years	1	0	1	1	0	0	0	0	0	0	0	0	0	0
Totals	60	42	18	172	34	48	15	26	7	13	44	56	45	108

This points up three facts. There is no surplus of numbers of persons but there is surplus talent which may be developed to strengthen present staffs and for expanded programs and which may not now be utilized fully. For example, there are now 73 engineering assistants in Minnesota who are reported to have the executive ability necessary to fill the top job in the county. This leads up to the second fact, that the scarcity may really be due to location and not to an absolute lack of talent. That is, there may be room for only one instrument man in County A although there are three rodmen who are capable of being instrumentmen whereas County B needs an instrumentman. This point will be discussed later. The third fact is that more money is needed so that more men can be employed and be started in the training process which has evidently been so successful to date.

The lack of money as a cause for present shortages of staff is supported by the opinion of 47.95 percent of the Minnesota engineers and 72.5 percent of the engineers in selected states.

[5] Only eight of the 36 selected states require assistant engineers to be registered.

TABLE 4

A DESCRIPTION OF COUNTY HIGHWAY DEPARTMENT STAFFS

Selected States - 77 Answering

No of CHE's Needed in		Has AE	AE registered	State requires regis	Hasn't AE	No of EA on staff	No of CHE's with EA's reg. or qualifying	No of such EA's	CHE's with EA's who are grad of eng schools	No of such grads	CHE's with EA's who are college trained	No of college trained	CHE's with EA's having exec ability to be CHE	No of these EA's	CHE's with personnel who can set grade lines	No of such personnel
1 year	7	5	3	2	2	23	3	7	3	10	4	11	5	7	6	16
2 years	3	2	1	0	1	8	1	5	2	4	2	8	2	6	3	8
3 years	5	3	1	0	2	22	2	3	2	4	2	3	2	3	3	12
4 years	5	2	0	0	3	7	2	3	1	1	2	3	2	3	3	6
5 years	11	9	4	2	2	29	4	8	4	5	8	12	8	12	7	13
6 years	3	3	1	0	0	7	2	3	1	2	1	2	3	3	3	5
7 years	2	2	0	0	0	7	1	5	1	5	1	5	1	3	1	4
8 years	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
9 years	2	2	1	0	0	14	1	6	1	4	1	6	1	2	2	15
10-13 years	16	12	1	1	4	52	7	14	4	6	9	14	8	10	7	13
14-17 years	13	10	4	1	3	50	5	12	4	7	6	15	6	7	7	19
18-21 years	8	6	4	2	2	20	4	7	3	4	4	8	4	7	4	18
Over 21 years	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
Totals	77	56	20	8	21	240	32	73	26	52	40	87	42	63	46	129

In Minnesota the inadequacy of personnel for the present workload is not great. Sixty-one counties reported a need for a total of 16 registered engineers, 32 instrumentmen, 40 chainmen, and 43 rodmen (see Column 1, Table 5).

In the selected states the shortage of manpower to carry the present workload as reported by 92 counties was distinctly larger. They indicate a need for 83 more assistant engineers, an increase of 106.41 percent; 69 more draftsmen, an increase of 80.23 percent; 50 more instrumentmen, an increase of 72.37 percent; and 43 more rodmen, an increase of 36.13 percent.

Some of these figures are puzzling. Does it seem reasonable that the counties will need greater numbers of professional men then they need of some types of sub-professional men; for example, instrumentmen and rodmen?

When these data were being analyzed the idea was advanced that these figures probably revealed an exaggerated need of the counties because they did not have sufficient profession manpower. Subsequently, data of all these counties which reported employment of a registered assistant engineer were analyzed. These are compiled in Table 7, but the same pattern persists. More than two times the number of assistant engineers than rodmen are reported as needed.

The next problem is: How much technical and professional personnel will be required for an expanded local road program? A series of questions was submitted to the county highway engineers to secure their estimates as to the different classes of personnel needed if the program were to be expanded by 25, 50, 75, and finally by 100 percent.

These estimates for Minnesota are shown in Table 5, and the pattern of these needs is pictured in Figure 5. These data indicate that the Minnesota men have carefully considered their engineering manpower needs. There is a consistent relation between the various categories of personnel. A 100 percent expansion over present programs calls for about three times as many personnel in each category as is needed for the present work load.

TABLE 5

PERSONNEL NEEDS FOR PRESENT WORKLOAD AND EXPANSION

Minnesota - 61 Counties Indicating Needs

	Present Workload	25% expansion	50% expansion	75% expansion	100% expansion
Registered Engineers	16[a]	14[b]	18[c]	31[d]	46[e]
Instrumentmen	32	40	52	77	96
Chainmen	40	53	79	111	140
Rodmen	43	61	77	97	125

Note: There are now in the 80 counties returning the questionnaires 55 AE's and 24 registered EA's, or 79 registered engineers on the staffs of the county highway departments in addition to the CHE's. The percent increase over this number as indicated by the above needs would be: (a) 20.25% (b) 17.72% (c) 22.78% (d) 39.24% (e) 58.23%.

TABLE 6

PERSONNEL NEEDS FOR PRESENT WORKLOAD AND EXPANSION

Selected States - 92 Answering Question

	Present Workload			+25%		+50%		+75%		+100%	
	Present staff	Additional men needed	% increase	Additional men needed	% increase	Additional men needed	% increase	Additional men needed	% increase	Additional men needed	% increase
Assistant Engineers	78	83	106.41	80	102 56	119	152.56	155	198 71	185	235 90
Draftsmen	86	69	80 23	76	88 37	127	147 67	165	191. 86	206	239 53
Instrumentmen	116	50	43. 10	61	52. 59	100	86. 21	135	116 38	161	138 79
Chainmen	76	55	72 37	75	98. 68	121	159. 21	170	223 68	194	255. 26
Rodmen	119	43	36. 13	61	51. 26	109	91. 60	145	121. 85	179	150 42

Note 66 CHE's or 72. 53% said they would hire more personnel if they has more money 69 of 70 41% said they would if the assistance were available 40. 91% of the CHE's answering think men needed for expansion are available. 73 96% of the CHE's said they could train the men needed.

TABLE 7

PATTERN OF INCREASE IN SELECTED STATES WITH REGISTERED ASSISTANT ENGINEERS

	Present Workload			+25%		+50%		+75%		+100%	
	Present staff	Additional needed	% increase	Additional needed	% increase	Additional needed	% increase	Additional needed	% increase	Additional needed	% increase
Assistant Engineers	31	26	83 87	21	67. 74	38	122. 58	54	174. 19	64	206. 45
Instrumentmen	44	17	38 64	14	31. 82	31	70. 45	44	100	51	115 91
Draftsmen	47	22	46 81	25	53. 19	47	100	63	134. 04	77	163 83
Chainmen	35	15	42. 86	16	45 71	30	85 71	50	142 86	58	165. 71
Rodmen	42	12	28. 57	14	33 33	37	88. 10	53	126 19	62	147 62

These data are shown in a different form on Figure 5.

The data from the selected states showing the anticipated needs for personnel in an expanded program are shown in Table 6. These same data were plotted on a chart to show the relations between the various classes of specialized personnel, Figure 6. (Note that needs in Figure 6 are expressed in percentages rather than in numbers of men.)

Attention should again be directed to the fact that the 92 county highway engineers from the selected states, as was seen in the report of needs for their present staff, have indicated greater needs for additional professional assistance for expanded road programs than for sub-professional personnel. For instance, for 100 percent expansion, the engineers said they needed 184 more registered engineers (or 235. 9 percent increase over present staff) and 179 more rodmen (150. 42 percent over present staff). Because of the apparent inconsistency between the requests reported by Minnesota county

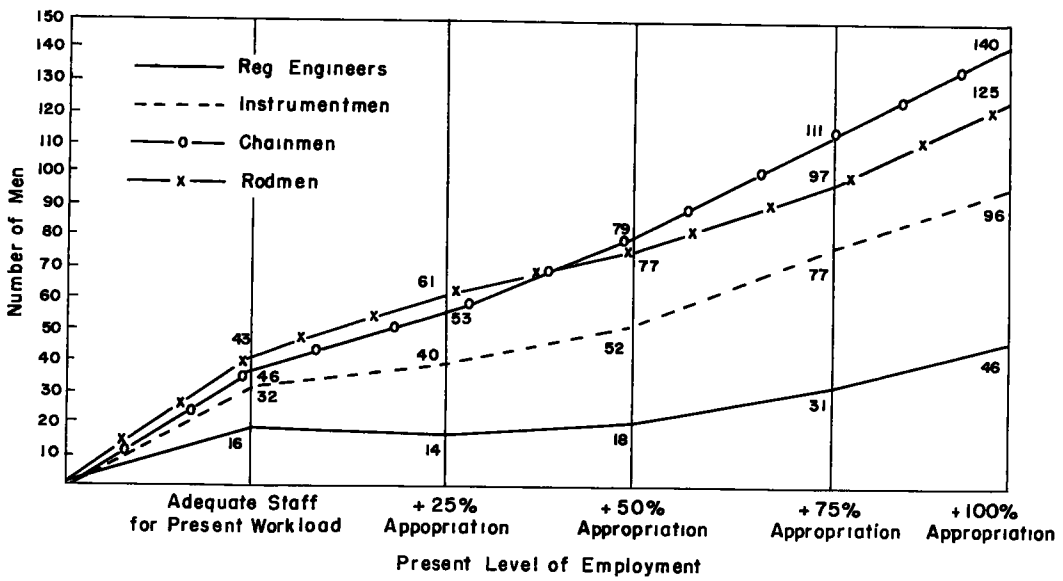

Figure 5. The pattern of personnel needs, adequate staffs for present workload and expansion in Minnesota - 61 Minnesota counties reporting.

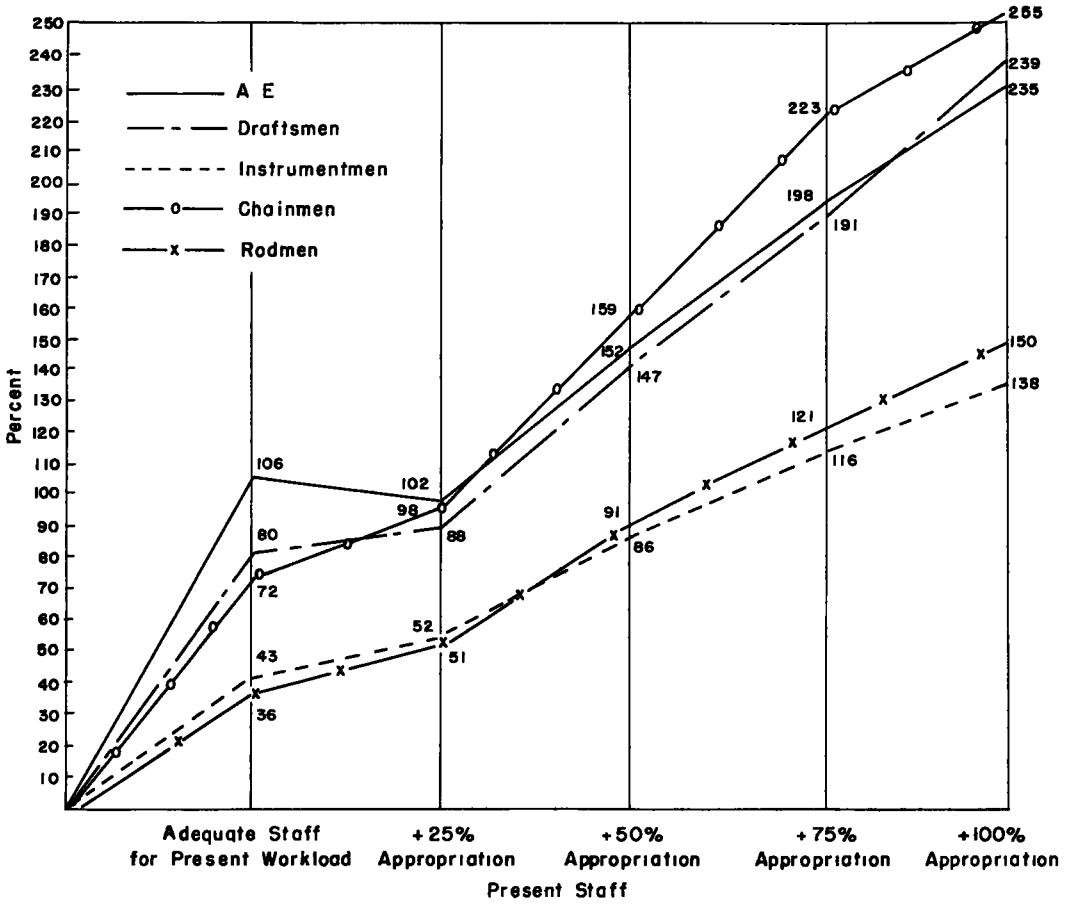

Figure 6. Pattern of personnel needs in selected states for present workload and expansion (in percentages), 92 county highway engineers reporting.

engineers and those of the selected states, it seems impossible to devise any formula to determine the needs for the various categories of personnel in expanded programs. A question arises as to the validity of the judgments as to personnel needs for an expanded program.

We come now to the problem: Will there be enough persons available to do the specialized work if the local road program is expanded? The answer to this question ulitmately depends upon the value which future job hunters attach to county employment. Will enough of them prefer it over that offered by competing employers? The pert, easy, but basically unsound answer usually turns on pay scales. If the pay is high, so run the comments, the positions will be filled. If pay were the only factor, the ranks of many callings would now be empty. Once minimum pay level is attained, then other considerations such as prestige, security, opportunity for advancement, working conditions, are as important or perhaps even more important then pay.

Let us approach the question from the standpoint of the opinion of the county highway engineers themselves as to whether a sufficient number of qualified personnel can be secured. Data in the questionnaires show that they think they can.

Sixty-four Minnesota county highway engineers answered the question on this point; 34 of them thought the necessary men could be obtained, 75 answered the question about their ability to train the needed men and 85 percent of those answering thought they could train them. The county highway engineers in the selected states were not quite so optimistic with respect to securing needed personnel.

The county highway engineers in the selected states were asked to indicate which of

the categories of qualified personnel they could train. Those answering thought they could train from 81 to 96 percent of the various classes. It is interesting to note that they thought they could train 96 percent of the needed chainmen and 94 percent of the needed registered engineers. They were not so sanguine about training assistant engineers or draftsmen. The estimate of the numbers which they could themselves train was only 81 percent.

This confidence in being able to train qualified personnel may smack of over-confidence. What is their training record? To begin: (1) The county highway engineers particularly in Minnesota are not, as a rule, graduates of engineering schools. Some of them have not attended college. Only 15 percent of the Minnesota engineering assistants were trained in engineering schools and only 7. 46 percent of the engineering assistants are graduate engineers. In the selected states 32 percent of the engineering assistants were trained in engineering schools and 18. 79 percent were graduates of engineering schools. (2) Despite their lack of formal training they have graduated men from their staffs to top level jobs in the counties and to equally responsible jobs in other services. Twenty-six Minnesota engineers reported that 42 of their engineering assistants had become county engineers and 30 in the selected states reported 68 of their engineering assistants had achieved like advancement. Minnesota counties supplied 75 men to jobs in other places of equal responsibility and in the selected states 184 had taken similar positions. (3) Their present staffs have been shown earlier in this paper to have a surprising amount of technical and professional talent.

When these facts are brought together, the record shows the estimate of these county men of their own ability to produce the technical and professional manpower to manage an increased program is no idle boast.

The position of county highway engineer appears from the evidence in the questionnaire to be satisfactory to those who are in it. It was pointed out above (see Figures 1 and 2) how the engineers plan to continue in their position of county highway engineers so long as they are physically able. Further evidence of their satisfaction with their jobs is to be found in the data on years of service. Table 8 shows this for both Minnesota and selected states.

TABLE 8

Years of Service	Minnesota (79 answering)	Selected States (103 answering)
1 - 5	18	17
6 - 10	16	25
11 - 15	11	8
16 - 20	10	17
20+	24	36
Total	79	103

On the other hand county work appears not to have been as attractive to assistant engineers in either Minnesota or in the selected states since 2½ times more of them went into other occupations as became county highway engineers. Or it may have been that opportunities did not occur for them to become county highway engineers. But whether it was in preference for other employment or lack of opportunity, this leads to the suggestion that some kind of arrangement be established whereby available technical and professional personnel and the demand for it can be brought together.

The Assoication of County Highway Engineers in Minnesota provides this service for its members. When a county engineer vacancy occurs, the secretary of the Association sends a notice to each of the other 87 engineers. A vacancy in one conty may result in as many as five shifts being made. This kind of arrangement could be extended to include all professional and sub-professional personnel between county and state highway departments if salaries are sufficient to make moves attractive.

One Minnesota county highway engineer remarked to the writer that the high schools were full of boys who want to earn money during the summer. In the time these boys are available to work with a field crew their aptitudes are discovered and interests de-

veloped. But, he said, although he had found many boys who appeared promising, his organization was too small to provide a ladder for their advancement. This indicates that some way should be found whereby technical and beginning professional personnel may be given work and responsibility in accordance with developing talent. This is done in states for county engineers like Minnesota and Michigan, when the engineers move from county to county. However, it would seem that a twofold type of advancement might be possible if the proper machinery to accomplish it were provided, movements from county to county and movement back and forth between state and county highway departments. Already a high cooperative attitude is being shown in some states to assist local road jurisdictions with their technical and professional personnel.

For example, the Minnesota State Highway Department permits members of its staff to take positions as county highway engineers. They are given leaves of absence from their jobs with the state highway department. They do not lose Civil Service status, and they are free to return whenever they please. Further, the state department permits technical persons to work with state crews in order to improve their training. For example, counties may send concrete or bituminous inspectors to join a state crew for a period. Cooperation of this kind should be extended so that technical personnel could expect to find work in keeping with increasing knowledge and skills.

Ladders of advancement from county to county and from county to state highway departments are just one aspect of improving the atrractiveness of road work. A similar ladder should be established across state lines. Recently an Iowa man was given the executive position in a Michigan county. The engineer in one of the larger Michigan counties was attempting to employ this man for his staff. The Michigan man was at the same time asked by a county road commission of a county of which he had formerly been the engineer to recommend someone. When he reported what he knew about the Iowa man the commission proceeded to appoint him.

The movement of professional personnel across state lines in not unusual. City managers are not confined by state lines. Neither are school men. The interchange of public school people has developed so far that arrangements are being developed for reciprocal retirement credit. California, Ohio, Illinois, among other states, take men from engineering schools wherever they can find them.

In a time when it appears that not only is the present supply of professional men too small to meet the demand but it is likely to continue to be too small in the foreseeable future, it would appear to be an act of wisdom to open up all the possible doors of advancement for highway personnel. For it to become known that jobs will be available to match the capacity is one of the most certain ways of attracting young men to prepare themselves for them. The high school boys who take a summer job on a survey crew are more likely to go to college when they are laid off in the fall if it becomes common knowledge that there will be a job waiting when they finish. The supply of capable young men with intellectual capacity to use a college education has not been exhausted. One sociologist estimated that only half of those with the ability to do college work actually go to college.

And may I add that despite the opinion of the men who filled out the questionnaires for me that they could train nearly all of the personnel needed to step into their places and to carry on the expanded road program, we must hope for more and more school-trained professional men. The job they are doing is too complex; the knowledge they need is too profound and is developing too rapidly for our society to depend upon learning by doing alone. Opening the way for advancement across county and state lines between departments and counties would probably have a most beneficent effect in publicizing the inherent advantages of the highway engineering profession. And it could have a most beneficial effect on salaries.

The machinery for doing this could take many forms. City managers use their own association to bring the vacancy and the prospective manager together. Notices of vacancies appear in their journal and in their newsletters. Their executive secretary is a kind of walking employment office. The same kind of thing could be done by journals which are available to road men. Notices of needs for personnel and notices of men wishing positions could be listed in the County Officer, the Journal of the National Association of County Officials. Likewise the monthly journals published for the benefit

of the county road men could also carry such information.

This may be a problem which the Board of County Engineering Consultants of the Chief of the Secondary Branch of the Bureau of Public Roads might well consider. It could be that the Council of State Governments might find ways to assist with this. The county engineers themselves might want to organize for purposes of collecting and disseminating information in respect to job opportunities. Or it may be that the local division of the American Road Builders Association would welcome an extension of its activity for such a service.

Two objections, among others, may be raised to such proposals as these. A county engineer may be willing to have the way open for himself but balk at full cooperation in opening the way for members of his staff. This would be a short-sighted attitude. Improving the status, opportunities, and prestige of road men everywhere redounds ultimately to the benefit of all men and for the benefit of the country. True enough, an engineer may have his program demoralized by his assistant engineer leaving him on June 1, but if the machinery is available to take away his chief lieutenant, it should also be available for him to secure another.

In the second place, state interchange of personnel may seem to be impractical because legal residence as a qualification for public employment is required by law in some states. Often a close examination of such law reveals a way to avoid it. For example, such a restriction may bar hiring an official but not an employee. In that case a non-resident can be given the status of an employee; when he has established legal residence he then can be given the official position. It is believed that a considerable number of states do not have statutes barring the employment of non-residents. These could establish the practice and if it worked, the basis for asking for the repeal of undesirable statutes of other states would then be established.

The advantages of erecting ladders of promotion for technical and professional personnel are of inestimable value in establishing better pay, and in improving the status of the profession. The freedom to move from county to county in Minnesota coupled with the publication of pay rates has tended to put a floor under salaries. A county board is reluctant to admit that its county is willing to put up with a second rate engineer. Further, good engineers are freed from servile dependence upon a job if the policy controlling in that place does not permit the use of sound and efficient practice.

It might seem in the first instance that a system of promotion across state lines would rob the poorer states of most of their best technical and professional talent. A more mature consideration of the matter will suggest that such procedure might be the best way to improve their practice. The first step toward improvement is a recognition of the need for improvement. An exodus of talent would provide a dramatic evidence of the need.

It may be concluded that an expanded road program could have a long run effect to cure present shortages of manpower and to improve the quality of technical and professional personnel.

ACKNOWLEDGMENTS

The investigation upon which this paper is based was supported by a grant-in-aid from the Automotive Safety Foundation. The writer is deeply indebted to Mrs. Wm. J. Siffin and Mrs. James G. Houston for compiling and analyzing data.

Appendix

COUNTY HIGHWAY ENGINEERING MANPOWER (MINNESOTA)

A symposium on highway engineering manpower is being planned for the January meeting of the Highway Research Board. The following questions are designed to provide some factual data on the visible and potential supply of engineering ability at the county level.

This questionnaire was sent to the 87 counties of Minnesota. Eighty questionnaires or 91.95 percent were returned.

Please note that the following abbreviations were used:

CHE = County Highway Engineer
AE = Assistant Engineer
EA = Engineering Assistant

The Potential Demand

1. How many years do you plan to continue as a county highway engineer?
   (a) 60 answered the question.
   They plan to continue:

1 - 2 years	3	10 - 13 years	21
3 - 5 years	16	14 - 19 years	9
6 - 9 years	5	over 20 years	6

Potential and Capacity of Engineering Assistants

1. Do you have an assistant engineer?
   (a) 78 answered the question.
   (b) 55 or 70.51 percent have AEs. Their ages are:

21 - 24 years	1
25 - 29 years	6
30 - 34 years	9
35 - 39 years	6
40 - 44 years	10
45 - 49 years	10
50 and above	9

   Four did not indicate the age of their AEs.
   AEs in Minnesota are required to be registered.

2. How many engineering assistants do you have?
   (a) Number of CHEs with one or more EAs, 78.
   (b) 78 CHEs have 228 EAs or an average of 2.92 EAs per county.

3. How many are registered?
   (a) 79 answered the question.
   (b) There are registered EAs in only 12 counties, and the total number of assistants registered is 24.
   (c) This means 10.53 percent of the EAs in all the counties are registered. (24 of of 228 EAs registered)

4. How many show the executive ability necessary to be a county highway engineer?
   (a) 78 answered the question.
   (b) 59 CHEs said they had 73 EAs with this ability.
   (c) This means that 32.02 percent of the EAs in all the counties have necessary executive ability. (73 EAs out of 228 EAs)

5. How many are technically qualified to be engineers?
   (a) 79 answered the question.
   (b) 46 CHEs answered that they had 63 EAs technically qualified to be engineers.
   (c) This indicates that 27.63 percent of the EAs in the counties (63 EAs of 228 EAs) are technically qualified to be engineers.

6. How many of the non-registered engineering assistants are qualifying themselves for registration?
   (a) 78 answered the question.
   (b) Only 18.42 percent or 42 of the 228 EAs in all the counties are qualifying themselves for registration.

7. How many of your engineering assistants are over fifty years old?
   (a) 78 answered the question.

(b) Only 15 counties have EAs over 50 years old. There are 25 such men; this means that only 10.96 percent of the EAs in all the counties are over 50.

Training

1. How many of your engineering assistants were trained in an engineering school?
   (a) 79 answered the question.
   (b) 35 out of the 228 EAs or 15.35 percent were trained in an engineering school.
   (c) These 35 EAs are in 22 of the 79 counties replying to this question.

2. How many are graduates of an engineering school?
   (a) 78 answered the question.
   (b) Only 17 of the 228 or 7.46 percent of the EAs in all the counties are graduates.
   (c) These 17 men are in 11 counties; 68 counties have no EAs who are graduates of engineering schools.

3. Exclusive of those mentioned above:
   (a) How many employees do you have who can set a grade line and figure quantities?
      (1) 79 answered the question.
      (2) 60 of the CHEs had 142 men who can set grade lines.
   (b) How many employees do you have who can operate an instrument?
      (1) 80 answered the question.
      (2) 73 of the CHEs had 176 men who can operate instruments.
   (c) How many rodmen or chainmen have you who are capable of becoming instrumentmen or draftsmen?
      (1) 79 answered the question.
      (2) 57 of the CHEs answered affirmatively and indicated they had 97 men in this category.

4. How many engineering assistants have you had who have:
   (a) Become county highway engineers?
      (1) 78 answered the question.
      (2) 26 CHEs or 33.33 percent of those answering indicated that 42 of their EAs have become county highway engineers.
   (b) Gone into other equally responsible positions?
      (1) 75 answered the question.
      (2) 40 of the 75 CHEs or 53.33 percent of those answering have had 105 EAs who have become the equivalent of CHEs.
   Note: The answers to (a) and (b) above suggest that advancement is out instead of up.

5. The answer to the above questions would have more meaning if the number of years you have served as a county highway engineer were known. That number is?
   (a) 79 CHEs answered the question.
   (b) They have served:

1 - 5 years	18	11 - 15 years	11
6 - 10 years	16	16 - 20 years	10
	20 or more years	24	

Workload

1. Do you need more engineering assistance now?
   (a) 80 answered the question.
   (b) 34 or 42.5 percent need more engineering assistance now.

2. With your present workload would you employ more engineering assistance if:
   (a) You had more money?
      (1) 73 CHEs answered the question.
      (2) 35 of these or 47.95 percent could employ more engineering assistance with more money.
      (3) 38 or 52.05 percent would not employ more.

(b) If the assistance were available?
(1) 66 answered the question.
(2) The answer was split 50-50.

3. If the answer is yes, how many more of each class would you now employ:
(a) 32 CHEs want 43 more rodmen; an average of 1.3 additional rodmen per county requesting.
(b) 26 CHEs want 40 more chainmen; an average of 1.5 more per county requesting.
(c) 30 CHEs want 32 more instrumentmen; an average of 1.06 more per county requesting.
(d) 12 CHEs want 16 more engineers; an average of 1.33 more per county requesting.

4. How many of your technically trained personnel spend time on non-technical work?
(a) 68 answered the question.
(b) 22 CHEs answered they had a total of 33 persons doing such work, an average of 1.5 persons per county staff involved.

5. What percentage of the time of these persons is spent on non-technical work?
(a) These 33 persons spend an average of about 25 percent of their time on non-technical work, although individually the percentages ranged from 5 to 90 percent of their time.

6. If the money available to your department were to be increased, indicate how it would affect your need for engineering assistance. If the money were to be increased -

25 percent — You would need:

Rodmen - 41 CHEs wanted 61 more.
Chainmen - 37 CHEs wanted 53 more.
Instrumentmen - 37 CHEs want 40 more.
Registered Engineers - 13 CHEs want 14 more.
48 CHEs indicated needs for increased staffs with a 25 percent increase in appropriation.

50 percent — You would need:

Rodmen - 53 CHEs want 77 more.
Chainmen - 49 CHEs want 79 more.
Instrumentmen - 46 CHEs want 52 more.
Registered Engineers - 15 CHEs want 18 more.
56 CHEs indicated needs for increased staffs with a 50 percent increase in appropriation.

75 percent — You would need:

Rodmen - 48 CHEs want 97 more.
Chainmen - 48 CHEs want 111 more.
Instrumentmen - 49 CHEs want 77 more.
Registered Engineers - 24 CHEs want 31 more.
54 CHEs indicated needs for increased staffs with a 75 percent increase in appropriation.

100 percent — You would need:

Rodmen - 52 CHEs want 125 more.
Chainmen - 51 CHEs want 140 more.
Instrumentmen - 54 CHEs want 96 more.
Registered Engineers - 33 CHEs want 46 more.
58 CHEs indicated needs for increased staffs with a 100 percent increase in appropriation.

7. Could you obtain the men needed for handling increased funds?
(a) 64 answered the question.
(b) 34 or 53.13 percent of the CHEs think the men are available.

8. Could you train these men?
   (a) 75 answered the question.
   (b) 64 of the 75 or 85.33 percent thought they could train the men.

COUNTY HIGHWAY ENGINEERING AND TECHNICAL MANPOWER (SELECTED STATES)

This questionnaire was sent to the heads of 182 local road jurisdictions in 36 states. One hundred nineteen or 65.38 percent were returned. Five of the questionnaires were not used in the tabulation because the data were obviously not representative and would have distorted the averages.

The following abbreviations were used:

CHE - County Highway Engineer
AE - Assistant Engineer
EA - Engineering Assistant

The Potential Demand

1. How many years do you plan to continue as a county highway engineer?
   (a) 77 answered the question.
   (b) They plan to continue:

1 - 2 years	10	10 - 13 years	16
3 - 5 years	21	14 - 19 years	14
6 - 9 years	8	over 20 years	8

Potential and Capacity of Engineering Assistants

1. Do you have an assistant or deputy engineer?
   (a) 106 answered the question.
   (b) 78 or 73.58 percent have AEs.
   (c) Their ages are:

21 - 24 years	2
25 - 29 years	9
30 - 34 years	11
35 - 39 years	2
40 - 44 years	8
45 - 49 years	14
50 and above	28

   (d) 30 of the AEs or 38.46 percent are registered.

2. Does your state require that your deputy or assistant engineer be registered?
   (a) 74 answered the question.
   (b) Number of states requiring AEs to be registered, 8, or 22.22 percent of the 36 states represented in the questionnaire.

3. Other than the assistant engineer how many engineering assistants do you have?
   (a) Number of CHEs with one or more engineering assistants, 84.
   (b) Number of such EAs, 346 or an average of 4.12 EAs per county.
   (c) 15 CHEs did not have an engineering assistant.

4. How many are registered?
   (a) 98 CHEs answered the question; only 22 of them had one or more registered EAs.
   (b) The number of registered EAs is 38; or 10.99 percent of the EAs in all the counties are registered.

5. How many show the executive ability necessary to be a county highway engineer?
   (a) 95 answered the question.
   (b) 62 CHEs said they had a total of 90 EAs with this executive ability. These 90 EAs are 26.01 percent of all the EAs in the counties studied (90 EAs out of 346).

6. How many are technically qualified to be engineers?
   (a) 86 answered the question.
   (b) 55 CHEs said they had 90 EAs technically qualified to be engineers.
   (c) These EAs equal 26.01 percent of the assistants in all the counties.

7. How many of the non-registered engineering assistants are qualifying themselves for registration?
   (a) 86 answered the question.
   (b) 37 CHEs said they had 54 EAs (15.61 percent of the EAs in all counties) qualifying themselves for registration.

8. Of these assistants, how many are classified as rodmen, chainmen, instrumentmen, draftsmen?

Rodmen, 119 Chainmen, 76 Instrumentmen, 116 Draftsmen, 86	Note: The total of these engineering classifications is 397 as opposed to the 346 EAs the CHEs said they had in question 3. Evidently some staff members serve in a dual capacity and therefore were counted in more than one category.

9. How many of your engineering assistants are over fifty years of age?
   (a) 47 counties had EAs over 50 years of age.
   (b) There are 85 such men; this means that 24.57 percent of the EAs in all counties are over 50 years of age.

Training

1. How many of your engineering assistants were trained in an engineering school?
   (a) 87 answered the question.
   (b) 59 CHEs said they had 111 EAs who were trained in an engineering school. This is 32.08 percent of the 346 EAs.

2. How many are graduates of an engineering school?
   (a) 85 answered the question.
   (b) 39 CHEs said they had 65 EAs who were graduates of engineering schools. 18.79 percent of the 346 are graduates.

3. Exclusive of those mentioned above:
   (a) How many employees do you have who can set a grade line and figure quantities?
      (1) 94 answered the question.
      (2) 65 counties have 184 EAs who can set grade lines and figure quantities.
   (b) How many employees do you have who can operate an instrument?
      (1) 95 answered the question.
      (2) 73 counties have 219 EAs who can operate an instrument.
   (c) How many rodmen or chainmen have you who are capable of becoming instrumentmen or draftsmen?
      (1) 86 answered the question.
      (2) 61 counties have 120 rodmen who could become draftsmen.

4. Do you prefer for your instrumentmen to be registered engineers or registered surveyors?
   (a) 98 answered the question.
   (b) 62 CHEs prefer that their instrumentmen be engineers; or 63.27 percent.

5. Do you prefer for your draftsmen to be registered engineers?
   (a) 97 answered the question.
   (b) 50 of the CHEs or 51.55 percent prefer that their draftsmen be registered engineers.

6. How many engineering assistants have you had who have:
   (a) Become county highway engineers?
      (1) 85 answered the question.
      (2) 30 CHEs (or 35.29 percent of those answering) have had 68 EAs become CHEs.

(b) Gone into other equally responsible positions?
(1) 56 CHEs (or 65.88 percent of those answering) have had 184 EAs become the equivalent of county highway engineers.

7. The answer to the above questions would have more meaning if the number of years you have served as a county highway engineer were known. That number of years is —

(a) 103 answered the question.
(b) They have served:

1 - 5 years	17
6 - 10 years	25
11 - 15 years	8
16 - 20 years	17
20 or more years	36

Workload

1. Do you need an assistant or deputy engineer?
(a) 73 CHEs out of 108 answering, or 67.59 percent, said they needed an assistant engineer.

2. With your present workload would you employ more engineering assistance:
(a) If you had more money for salaries?
(1) 66 CHEs out of 91 answering, or 72.53 percent, said they would hire more engineering assistance if they had more money. 25 CHEs would not hire more men.
(b) If the assistance were available?
(1) 69 CHEs out of 98 answering, or 70.41 percent, said they would hire more men if the assistance were available. 29 CHEs would not hire more men.

3. If the answer is yes, how many more of each class would you now employ:

Additional Men Needed		Percent Expansion Over Present Staff
Assistant Engineers	83	106.41
Draftsmen	69	80.23
Instrumentmen	50	43.10
Chainmen	55	72.37
Registered Engineers	43	36.13

4. If the money available to your department were to be increased, indicate how it would affect your need for engineering assistance. If the money were to be increased 25 percent, you would need:

Additional Men Needed		Percent Expansion Over Present Staff
Assistant Engineers	80	102.56
Draftsmen	76	88.37
Instrumentmen	61	52.59
Chainmen	75	98.68
Registered Engineers	61	51.26

If the money were to be increased 50 percent, you would need:

Additional Men Needed		Percent Expansion Over Present Staff
Assistant Engineers	119	152.56
Draftsmen	127	147.67
Instrumentmen	100	86.21
Chainmen	121	159.21
Registered Engineers	109	91.60

If the money were to be increased 75 percent, you would need:

Additional Men Needed		Percent Expansion Over Present Staff
Assistant Engineers	155	198.71
Draftsmen	165	191.86

Additional Men Needed		Percent Expansion Over Present Staff
Instrumentmen	135	116.38
Chainmen	170	223.68
Registered Engineers	145	121.85

If the money were to be increased 100 percent, you would need:

Additional Men Needed		Percent Expansion Over Present Staff
Assistant Engineers	184	235.90
Draftsmen	206	239.53
Instrumentmen	161	138.79
Chainmen	194	255.26
Registered Engineers	179	150.42

5. Could you obtain the men needed for handling increased funds?
   (a) 88 answered the question.
   (b) 36 or 40.91 percent think the men are available for expanded programs.

6. Could you train these men?
   (a) 96 CHEs answered the question.
   (b) 71 or 73.96 percent of the CHEs say they could train the men needed.

7. If you cannot train all of them, how many of them could you train?
   (a) 26.04 percent of the CHEs said they could not train all the men needed.
   (b) The percentage needed for 100 percent expansion which could not be trained, however, is very small. The percentages which the CHEs indicated they could train are as follows:

Assistant Engineers	81.27 percent could be trained
Draftsmen	81.45 percent could be trained
Instrumentmen	85.78 percent could be trained
Chainmen	96.39 percent could be trained
Registered Engineers	94.59 percent could be trained.