PROJECTED FEDERAL GOVERNMENT COMPUTER PERSONNEL NEEDS: RESULTS OF AN OKLAHOMA SURVEY

by

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The purpose of this paper is to report the results of a study made to determine the projected performance requirements and skills (training needed) by personnel entering governmental information processing jobs during the next several years as viewed by supervisors in governmental agencies. The specific problems addressed are as follows:

1. The identification of the performance requirements for computer programmers and systems analysts which government employers expect to be needed for employment in the field of information processing during the last half of the 1980's;

2. The effectiveness of currently employed computer programmers and systems analysts as determined by supervisor assessment;

3. Identification of the areas in which colleges and universities will need to make curricular changes in order to provide the government as well as the business community with properly trained professionals in information processing.

The statistical data were obtained from supervisor assessments of the academic preparation and qualifications of those hired into government positions as computer professionals. In addition, the desires of these supervisors for future curriculum requirements were included as a part of the questionnaire responses. The questionnaire was given to sixty information processing supervisors in governmental agencies within the state of Oklahoma. Fifty seven of these completed and returned their questionnaires. The responses of the supervisors are tabulated in Figure 1. The analysis of figure 1 is organized in three sections corresponding to the three main problems addressed in this study.

Performance Requirements

Hiring Trends

Questions 1 and 3 were used to address the hiring trends of programmers and system analysts. While question 1 asks specifically for past hiring trends, question 3 asks for future hiring expectations. Increases are anticipated for both programmers and systems analysts. The anticipated percentage increase in demand for programmers is 18.3% and for systems analysts is 44.4%. The questionnaire respondents clearly indicate that the demand for programmers and systems analysts will continue to be strong during the next five years. However, the demand for systems analysts is expected to be much stronger than that for programmers.

1. How many employees have been hired in the past five years that were placed into the following types of positions?

Programmers   420

Systems Analysts   178

2. What academic qualifications did those employees have?
Please indicate by placing numbers in the proper spaces.

	No Degree	Associate Degree	Bachelor's Computer Minor	Bachelor's Computer Major	Masters Computer Major
Programmers	235	57	75	44	9
Systems Analysts	19	15	43	88	13

3. How many do you expect to hire in the next five years?

Programmers   497

Systems Analysts   257

4. What academic qualifications would you prefer for those you expect to hire in the next five years?

No Degree	Associate Degree	Bachelor's Computer Minor	Bachelor's Computer Major	Masters Computer Major
0	0	7	46	2

5. How would you rate the preparation of those hired in the past five years? Indicate by placing numbers in the correct spaces.

	Poor	Below Average	Average	Above Average	Excellent
Programmers	9	69	247	78	17
Systems Analysts	1	27	103	45	2

6. What is your rating of the training currently offered by colleges and universities for the following positions.

	Poor	Below Average	Average	Above Average	Excellent
Programmers	0	5	12	13	1
Systems Analysts	0	0	15	23	11

Figure 1. Supervisors' responses.

7. Indicate your need for continuing formal education in the updating of computer skills of present employees.

Not Useful	Moderately Useful	Useful	Important	Very Important	No Opinion
0	3	6	15	32	1

8. How useful do you find training in the following areas for programmers and systems analysts?

	Not Useful	Moderately Useful	Useful	Important	Very Important	No Opinion
Business	2	12	22	11	9	1
Mathematics	1	2	15	21	16	2
Management	2	3	23	16	12	1
Accounting	2	12	21	11	8	3
Engineering	1	6	24	16	6	4

9. Indicate your projection of the usefulness of the following subjects in your area during the next five years.

	Not Useful	Moderately Useful	Useful	Important	Very Important	No Opinion
Database	0	1	5	14	36	1
Telecommunications	2	1	2	12	39	1
Networking	0	2	3	16	35	1
Microcomputers	0	1	7	19	29	1
Systems Analysis	0	0	7	14	35	1
Systems Design	0	1	3	20	32	1
Computer Security	1	2	8	18	27	1
COBOL	8	7	12	18	11	1
PASCAL	17	12	17	4	1	6
ADVANCED COBOL	8	9	8	12	18	2
ASSEMBLER	6	7	21	13	8	2
ADA	9	9	6	18	10	5

Figure 1. Continued.

Question two dealt with the academic qualifications of previously hired employees, while question four covered the desired academic qualifications with respect to future hirees.

Fifty-six percent of the programmers used by the federal government during the past five years did not possess any type of college degree. To explain this phenomenon, it must be understood that many of these were military personnel who received their programming training from military schools and were given additional on-the-job training to qualify them to perform as programmers. Since 13.5% of the programmers have earned an associate degree, this shows that approximately 70% of the programmers used by the federal government do not have a bachelor's degree.

Of those programmers with a bachelor's degree, 75 had a degree with a computer minor while only 44 received their bachelor's degree with a concentration of studies in the field of computer science. Finally, only 2.1% of the programmers hired during the past five years had completed a master's degree with a computer major.

In contrast to the results shown for programmers, the academic background of systems analysts hired during the past five years is quite different. One hundred forty four of 178 systems analysts, 80.9%, had at least a bachelor's degree. Of the 131 that have a bachelor's degree, 88, or 67.2%, have a major in computer science. Of the remaining systems analysts, 19 persons or 10.7% of the total have no degree. In addition, 13 or 7.4% of the systems analysts have a master's degree.

One conclusion suggested by these results is that although it is reasonably straight-forward to train programmers on the job, this is not the case for systems analysts.

The results of question 4 reflect the preferences of supervisors responsible for obtaining future programmers and systems analysts. It is worth noting that such managers express strongly their preference for individuals with bachelor's or master's degrees. Actually, it is remarkable to note that from the sample returns of 57 managers, none expressed a preference for individuals with less training than that required to earn a bachelor's degree. It also should be noted that 83.7% of those managers desired that all employees entering the fields of programming or systems analysis should have a bachelor's degree with a major in computer science.

The results of questions 2 and 4 seem to suggest that although the past and current experiences in hiring programmers and systems analysts show that such individuals were hired without a bachelor's degree in the past, supervisors would like to increase the performance requirements in the future by requiring new programmers and systems analysts to have bachelor's degrees with computer science majors. The data suggest a major change in hiring policies of supervisors responsible for obtaining programmers and systems analysts.

One implication suggested by the above results is that according to the survey, there seems to be a strong market for

individuals with a degree in computer science. This means that academic credentials are highly valued by current government supervisors who hire computer programmers and systems analysts. In other words, in the future, supervisors will demand higher academic qualifications as a prerequisite for satisfying performance requirements.

Current Effectiveness

Rating of Present Computer Training

Analyses of questions 5 and 6 are presented in this section. The overwhelming majority of the programmers are rated as average. It should be noted that 247 out of a total of 420 programmers, that is 58.8%, are rated average. Only 95 programmers, 22.6%, received a rating higher than average. Seventy-eight or 18.6% received an above average rating and 17 or 4.0% received an excellent rating. The remaining 18.6% received a rating lower than average.

The majority of systems analysts, 103 out of a total of 178, that is 57.9%, were rated average. It is interesting to note that 45 or 25.3% of the systems analysts were rated above average. Although the results of rating programmers and systems analysts are very close for the below average and average categories, there are some differences in the other categories.

Specifically, 2.1% of the programmers were rated poor while only 0.6% of the systems analysts were rated in this category. However only 1.1% of systems analysts were rated excellent while 4.0% of the programmers were rated in this category.

Curriculum Evaluation

The respondents to question 6 will vary in number because not all supervisors have both programmers and systems analysts in their organization. It shows that no supervisors, of the 31 responding to this question, considered training of programmers by colleges and universities to be rated poor while only one supervisor considered such programmer training to be excellent. Twelve supervisors considered the training of programmers to be average while 13 considered the training of programmers to be above average.

Fifty-four point eight percent of the supervisors rated the training of programmers to be average or below average. No supervisors rated the training of systems analysts poor or below average. Only 30.6% of the supervisors rated training of systems analysts as average while the remaining 69.4% of the supervisors rated this training to be above average or excellent.

The data from question two indicated that most of the government programmers had no university training. This could be a factor in the resultant rating of the programmers in contrast, 38.7% of the supervisors rated current university training of programmers as average. Note also that while 18.6% of the programmers were ranked in the above average category,

42.0% of the supervisors considered college and university training for programmers to be above average. The implication is that personnel trained in college and university computer science programs are more likely to be hired in the future. These results also indicate that government supervisors value these college trained personnel more highly than those trained on-the-job.

No supervisor rated present college and university training of systems analysts as poor or below average. Of the supervisors responding, 69.4% this training as above average or excellent. In contrast to this, 15.2% of the currently employed systems analysts were ranked as below average, 57.9% were ranked as average, and 26.4% were rated in the two higher categories. These numbers also indicate that college and university trained systems analysts are highly valued and rated by their supervisors.

Curriculum Considerations

Continuing Education

Question 7 addresses the importance of formal continuing education in updating the computer skills of current employees. An overwhelming majority of supervisors, 83.9% rated continuing education as important or very important. Only 10.7% gave a rating of useful, and 5.4% considered continuing education moderately useful. No supervisors viewed continuing education as not useful.

The results shown here clearly establish the need for a current, up-to-date continuing education program in the computer science are. This information could be very useful for colleges and universities which have the resources to provide continuing education courses in their computer science curriculum.

Training in Associated Areas

At least 50% of the supervisors consider management and mathematics to be important or very important to personnel in the information processing profession. At least 25% of the respondents considered business and accounting to be less than useful as an associated area for programmers and systems analysts. Furthermore, in these two subject areas, business and accounting, the remaining supervisors, approximately 75%, rated them as useful or higher.

It is worth noting the order in which the supervisors rated the subjects in the more than useful category. The order was mathematics, management, engineering, business, and accounting. This suggests an order that colleges and universities should consider when they establish future associated curricular requirements for those majoring in computer science.

Table 1 shows the correlations between the usefulness of the five associated areas. Table 1 indicates that the highest correlations occur between business and management and between business and accounting. This suggests that supervisors who

value business as an associated area, would also like computer science majors to have management and/or accounting.

Table 1

CORRELATIONS BETWEEN USEFULNESS OF ASSOCIATED AREAS

	Business	Mathematics	Management	Accounting	Engineering
Business	1	.246	.520	.490	.015
Mathematics		1	.142	.110	.361
Management			1	.263	.015
Accounting				1	.341
Engineering					1

Supervisors who have these values would possibly prefer hirees who had training at some college or university that had a computer science curriculum similar to that proposed by the Data Processing Management Association (DPMA).

Table 1 also illustrates engineering correlates significantly with mathematics and accounting. This suggest that supervisors who like for them to also have courses in accounting and mathematics.

The supervisors making these choices would possibly like to have personnel with training similar to that as designated by the Association for Computing Machinery (ACM). Of course, the organizational mission would dictate the particular type of training requirements.

Projected Usefulness of Subjects

In analyzing the results of question 9, it is useful to divide the subjects into two broad categories, languages and non-languages.

In the non-language category, the first item evaluated in terms of projected usefulness by supervisors was database. Only one out of the 56 respondents to this item ranked database less than useful, while 5 ranked it as useful and the remaining 50, 89.3%, ranked database as important or very important.

Telecommunications exhibited a strong pattern of usefulness with only 3 of the 56 responding supervisors ranking it less than useful while 2 ranked it as useful and 51, 91%, ranked it as important or very important.

Networking was also valued as important or very important by 51, 91% of the 56 supervisors responding to this item, while only 3, or 5.4% considered it as useful. Only 2 supervisors ranked it as moderately useful and none considered it to be not

useful.

The microcomputer item was ranked less than useful by only one supervisor. That was in the ranking of moderately useful. Seven, 12.5%, of the 56 responding ranked microcomputers as useful and the remaining 48, 85.7%, ranked them to be either important or very important.

Systems analysis received no ranking in the less than useful categories. Only 7, 12.5%, of the 56 responding supervisors considered this subject to be useful while the remaining 45, 87,5%, ranked them to be either important or very important.

Systems design also received no ranking in the not useful category. One supervisor of the 56 responding to this item ranked this as moderately useful and 3, 5.4%, considered it as useful. The remaining 52, 92.8%, of the supervisors ranked this as either important or very important.

The last item in the non-language category is computer security. This item was ranked by 1 of the 56 responding supervisors to be not useful while 2 of them ranked it as moderately useful. Eight, 14.3%, ranked it as useful and the remaining 45, 80.3%, ranked it as either important or very important.

It should be noted that, with respect to curricular changes for colleges and universities offering a degree in computer science, all of the specific non-language subjects selected for study in this survey show a high projected demand. Colleges and universities offering a selection of these non-language subjects should expect to have above average enrollments during the next five years.

Computer languages comprise the next category of subjects to be analyzed. In contrast to the non-language items, the results show a diversity of opinion concerning the relative importance of these five languages. PASCAL was considered to be the least important language by the largest number of the supervisors. It should be noted that 29 of the 52 responding to this item, that is 56.9%, ranked it as less than useful. In contrast to PASCAL, COBOL was rated as important or very important by 29, 51.8%, of the 56 supervisors responding to this item while 12, 21.4%, rated COBOL as being useful.

ADVANCED COBOL is also considered to be more than useful by more than 50 percent of the supervisors responding. Specifically, 30 of the 51 supervisors responding to this item ranked it to be important or very important.

ASSEMBLER was ranked as useful by 21 of the 55 supervisors that responded to this item. The same amount, 38.2%, ranked it as either important or very important while 13, 23.6%, ranked it less than useful.

The last language considered is ADA. Eighteen of the 52 supervisors that responded to this item ranked this language as important while 10, 19.2%, ranked it as very important. Six of the supervisors considered ADA to be useful while 18, 34.6% ranked it as less than useful. This indicates that, although ADA is being developed by the Department of Defense, many current government supervisors do not see a need for expertise in this language at this time.

TABLE 2

CORRELATIONS BETWEEN USEFULNESS OF ASSOCIATED SUBJECTS

	DATABASE	TELECOMMUNICATIONS	NETWORKING	MICROCOMPUTERS	SYSTEMS ANALYSIS	SYSTEMS DESIGN	COMPUTER SECURITY	COBOL	PASCAL	ADVANCED COBOL	ASSEMBLER	ADA
DATABASE	1											
TELECOMMUNICATIONS	.369	1										
NETWORKING	.431	.804	1									
MICROCOMPUTERS	.116	.478	.463	1								
SYSTEMS ANALYSIS	.179	.172	.167	.315	1							
SYSTEMS DESIGN	.323	.185	.174	.252	.721	1						
COMPUTER SECURITY	.228	.427	.352	.043	.215	.452	1					
COBOL	.328	.379	.233	.158	.321	.358	.268	1				
PASCAL	.079	.187	.062	.168	-.102	.166	-.047	-.060	1			
ADVANCED COBOL	.353	.439	.281	.061	.373	.357	.296	.936	-.079	1		
ASSEMBLER	.130	.015	-.060	-.121	-.002	.154	.296	.189	.076	.309	1	
ADA	-.190	.124	.081	-.007	-.301	-.077	.252	.260	-.210	.476	.283	1

individuals in computer programming sand systems analysis. The findings obtained by analyzing the questionnaire responses suggest that college and university training is highly valued and these institutions must place primary emphasis on producing qualified individuals in the field of computer science. Within such an academic training, emphasis must be place on two areas. These are, associated subject areas and computer languages. This study identifies the importance given to mathematics and management by supervisors as desirable associated subjects for computer science students.

The supervisors were also specific in their choice of related curriculum areas. From their selections, two choices have emerged as to the type of curriculum desired. Some prefer engineering and mathematics as associated coursework similar to the ACM curriculum and others indicate a preference for a DPMA type of curriculum with business and management as associated coursework.

Finally, the same supervisors selected telecommunication, database, networking, systems analysis and systems design as very important non-language subjects. The responding supervisors selected COBOL and ADVANCED COBOL as the two most important language subjects.

Table 2 shows the correlations between the usefulness of the items in question 9. This table shows 3 strong correlations and 6 moderate correlations. In order of descending numerical value, the first 3 highest correlates are: first, COBOL and ADVANCED COBOL have a correlation of .936; second, telecommunications and networking have a correlation of .804; and third, systems analysis and systems design have a correlation of .721. This suggests that in the opinion of the supervisors surveyed, individuals that take COBOL should also take ADVANCED COBOL, those needing networking should also take telecommunications and those who choose system analysis should also consider systems design.

Of the remaining 6 moderate correlation, 3 are correlates with telecommunication. Telecommunications correlates with microcomputers with a coefficient of .478, telecommunications correlates with computer security with a coefficient of .427 and note also that telecommunications correlates with ADVANCED COBOL and computer security.

Networking shows a correlation with two other subjects. it correlates with microcomputers having a coefficient of .463 and with database having a coefficient of .431. This suggests that those who choose networking should also choose microcomputer and database as associated areas.

The remaining correlation is between system design and computer security. The correlation coefficient between these two subjects is .452. This indicates that personnel taking systems design should supplement such training with courses in computer security.

Summary

The major findings of our survey are summarized below.
The first problem identifies performance requirements for computer programmers and systems analysts which government employers expect to be needed during the last half of the 1980's. In contrast to the recent past when computer programmers were primarily trained on the job, future computer programmers are expected to have earned a bachelor's degree in order to meet the performance requirements of their supervisors. With respect to systems analysts, the study shows that their academic qualifications have been superior to those of computer programmers in the past and future performance requirements for system analysts include a strong academic training program leading to a bachelor's degree with a major in computer science.

The second problem requires the evaluation of the effectiveness of currently employed computer programmers and system analysts as determined by their supervisors. The study shows that system analysts are much more effective employees than computer programmers. One reason for this difference lies in the observed training differences of these two categories of employees.

Finally, the third problem identifies areas in which colleges and universities will need to make curricular changes in order to provided the government sector with properly trained