THE SELECTION AND TRAINING OF PEOPLE FOR THE HARDWARE SIDE OF THE COMPUTER INDUSTRY

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Our orientation in the Computer Personnel Research Group has perhaps been more in the area of software and operations, so I felt it would be appropriate if we considered the hardware side in my brief remarks today. I shall consider the selection and training of men to work as customer engineers or field engineers. These men are responsible for the installation, adjustment, checkout and the continuing maintenance of computer systems. Each computer engineer (C.E.) is generally responsible for several computer systems which are normally within driving range by auto.

Perhaps our first task is preselection rather than selection. To determine which psychological tests would be most pertinent in the prediction of C.E. success, our psychologist, Dr. Carroll I. Stein, interviewed a group of experienced field supervisors and instructors. The attributes that were generally sought after were listed in this order of importance: first, Learning Potential; second, Mechanical or Abstract Logic; and third, Motivation or Attitude.

In an effort to measure these attributes, the following tests were used:

A. Tiffin Adaptability — (A test made up primarily of verbal and numerical reasoning items which is designed to test for general learning potential.)
B. Minnesota Paper Form Board — (This is designed to measure one aspect of basic mechanical ability.)
C. Raven's Standard Progressive Matrices — (This uses symbolic rather than verbal analogies and measure a form of non-verbal logic.)
D. Flanagan Assembly and Components Test — (This measures several facets of mechanical ability.)
E. Kuder D Interest Test — (Used to infer intrinsic motivation by measuring types of activities an individual may be interested in.)

Having settled upon the tests that would be used, the next step was the establishment of criteria for measuring success in two areas of achievement; namely, academic success while in training and then success in the field after the completion of training. Under Training Criteria, we included: A — Terminations due to lack of ability; B — Class grade below average; and C — Comprehensive achievement examination. Under Field Success Criteria, we included: A — Periodic Merit Reviews, and B — a special rating form for Customer Engineers.

Upon initial investigation, it was apparent that some of the routine criteria, namely class grades and merit review records were not reliable enough for research purposes. It was at this juncture that one of our researchers, Clyde Hawkins and his staff developed a comprehensive achievement examination which met our needs for training criteria very well.

The problem with the standard merit reviews stemmed from the fact that supervisors tend to rate all employees above average. To compensate for this, a special C.E. rating form was developed which permitted the supervisor to weigh each area being rated according to its importance to the job. This technique resulted in a wider distribution of merit ratings.

The next step was the validation of the five tests that I mentioned earlier. Preliminary analysis indicated that Raven's Matrices and Flanagan tests were of little or no predictive value so they were the first ones dropped from consideration.

After a detailed analysis of the Tiffin Adaptability and Minnesota Paper Form Board, it was concluded that with a raw score cut off of 24 on the Tiffin test, we could differentiate accurately among the high and low achievers 70% of the time. There appears to be a linear relationship between learning potential and trainee achievement. As a consequence, it would follow that when the supply of applicants is plentiful, we can maximize the quality of our trainees by accepting those with the highest possible scores.

The Minnesota Paper Form Board did not hold up well when subjected to cross-validation. Only a minimal amount of the mechanical aptitude being tested seemed to be necessary and above this amount, there was no linear relationship with trainee achievement. It was found that greater prediction accuracy could be obtained by increasing the cut-off point on the Tiffin and dropping the Minnesota test completely.

Before moving on to the training of C.E.'s, it should be pointed out that we also noted a strong correlation between learning potential and our ability to predict success in the field for these C.E.,s. On one representative sample, the predictive accuracy using an adaptability cut-off score of 23 was 67.5%.

On the subject of interest and motivation, Dr. Stein is currently developing a special key for Control Data customer engineers. Preliminary investigation, using computerized techniques, indicates that this may be very useful in increasing our overall predictive accuracy.

At this point, I should like to move on to the matter of training these customer engineers. The preselection that we mentioned earlier, from the training standpoint, will serve to lower the termination rate and increase class homogeneity and thus facilitate instruction.

It might be well to say a word or two about the training facilities involved in this discussion since they differ from those found traditionally in the computer industry. Control Data Institutes are similar to the training facilities of other manufacturers in that we offer a wide variety of hardware, software and applications courses to our customers and to our employees. Where we differ is in the area of training opportunities which Control Data Institutes provide the public. Each of our schools, located in Los Angeles, Minneapolis, and Washington, D.C., offers to the public residence courses which lead to a career as a Customer Engineer, a Programmer or a Draftsman. These are skill areas in which we now have a grave shortage of trained people in our industry and sales forecasts indicate that this personnel shortage will become more acute in the years to come.

Now the object of the training that we are concerned with today is that which prepares the student for a career as a customer engineer. While we have a number of applicants who come to us with previous experience in

the computer industry, obviously the great majority have not. We do, however, prefer students with successful work experience in one of the fields of electronics.

Our minimum standard for admission is generally a high school diploma, but our experience thus for indicates that approximately 50% of our students have at least one year of schooling beyond high school, and indeed it is not unusual to receive applications from college graduates.

Using the Tiffin Adaptability Test as the prime preselection vehicle, our experience has been that we are accepting two out of every three applicants. When we find an applicant who is on the borderline, we will use a test from the California Mathematics Series to evaluate mathematics potential. If the score is above average in the California test, we will accept the applicant on a probationary basis.

I should like to digress for a moment here before we follow this young man through his course of training. When we started the first school in Minneapolis last year, there was considerable interest in what we were doing. Among those who were most interested was the Minnesota Department of Employment Security. Their interest stemmed from the fact that they, like the United States Bureau of Employment Security, are vitally concerned over selection criteria for new skill areas where we have a shortage of trained people. In an effort to assist the Minnesota Employment Security staff in the development of useful data in this field, we offered to let them administer their General Aptitude Test Battery to each student enrolled in our courses. While this testing has been going on now for a number of months, it is still too early to expect meaningful results as the first class will not graduate for another 60 days. I have been advised that the statistics developed in Minnesota will be passed on to the BES in Washington and then they will disseminate this information as appropriate to other States as well as to industry.

To return then to the training of this young man, it is necessary that we move on to the curriculum.

Most students come to us with a need for additional training in mathematics and with very little training in solid-state electronics. Where this is not the case, and the student has a good background in these fields, he is given the opportunity to qualify for advanced academic standing by passing the Advanced Standing Test which has been developed by the Staff. The average student is given a mathematics refresher course and the necessary grounding in Electronics.

Since I am the last speaker, and some of you are probably getting somewhat anxious to catch your transportation home, I suggest that you refer to the small newspaper entitled the Control Data Institute Reporter which is available at the rear door. This contains the entire curriculum in some detail along with other useful information about the schools.

Course Title: COMPUTER TECHNOLOGY
(1000 classroom hours)

PHASE I

I. Introduction to Basics of Electronics
II. DC Theory
III. Magnetics and Basic Meter Movements
IV. AC Theory
V. Motors and Generators
VI. Vacuum Tube Theory
VII. Transistor Theory
VIII. Electronic Circuits
IX. Digital Computer Circuits (Basic)

PHASE II

I. Digital Computer Circuits (Advanced)
II. Basic Programming
III. Basic Computer Software (FORTRAN)
IV. Computer Memory
V. Signal and Data Flow
VI. Arithmetic Section
VII. Block Control
VIII. Interrupt Sequences

PHASE III

I. Introduction to Peripheral Equipment
II. Introduction to Paper Tape Equipment
III. Paper Tape Reader
IV. Paper Tape Punch
V. Input/Output Typewriter
VI. Introduction to Magnetic Tape Sub-Systems
VII. Magnetic Tape Transport
VIII. Magnetic Tape Transport Controller
IX. Introduction to Punched Card Sub-Systems
X. Punched Card Reader (and Controller)
XI. Card Punch (and Controller)
XII. Introduction to Disc Pac Sub-Systems
XIII. Disc Pac Unit
XIV. Disc Pac Controller
XV. High Speed Line Printer
XVI. Digital-to-Analog Converter
XVII. Analog-to-Digital
XVIII. Visual Display Unit

Earlier I mentioned that we were faced with a shortage of these people in the industry. To give you an insight into the companies that have expressed an interest in hiring our graduates, I shall cite but a few: Burroughs Corporation, Continental Device Corporation, Control Data Corporation, Defense Electronics, Honeywell, IBM, International Telephone and Telegraph, Minnesota Mining and Manufacturing, Motorola, Lockheed, Texas Instruments, and a host of others.

As for the future, it is becoming increasingly evident that the man we have been talking about—the Customer Engineer—could work much more effectively if he were a qualified programmer. This suggests that our initial training course will have to be expanded or we will bring these men back from the field for additional software training after they have had a year or two of experience.

Before closing, it might be well to touch upon a couple of experimental projects that we have been asked to consider. The first is concerned with training a group of older workers between the ages of 45 and 55 for productive jobs in the industry. These are some of the facets of this problem that we will be considering in some detail:

1. To demonstrate the feasibility and effectiveness of training older workers for computer industry occupations.
2. To conduct research to determine the difference in training performance between older persons (45 — 55 years old) and younger persons (19 — 35 years old). Both groups will receive comparable training. Statistical techniques will be used in making comparative analyses. The older group will be trained in Los Angeles and the data on the younger group will be obtained from trainees at the Control Data Institute in Minneapolis, Minnesota.
3. To prepare a group of 100 underemployed or unemployed workers, 45 years of age or older, for productive employment in the computer industry.
4. To ensure that graduates of the training program are placed in computer industry employment which will require the skills developed by the program.

The other is a planned training project which will be conducted jointly with the public schools. Like the older worker mentioned earlier, the young man or woman who has not completed high school faces a bleak future from the standpoint of employment. We are now considering with the State of Minnesota a plan whereby the State would provide pre-vocational training to these young people and having successfully completed this, they would enroll at the Institute for the advanced training needed to qualify for a job in the computer industry.

In closing, may I say that it has been a privilege to speak to you here today, and I look forward to seeing you again next year.

DISCUSSION

Massey: I'd like to comment concerning Dr. Larsen's paper. I note the selective process which has been taking place in actually determining the students who are enrolled in the courses and the information which is being collected on their general aptitude test battery recognizes that the students who do not get into the course are possibly the students with quite different interests and are not included with the sample. This is the sort of situation you get when you try to find out if a medical diagnostic test works by just applying it to well people. The second comment is on Peter Wegner's paper.

He described what to me seems is an extremely attractive program — the sort of thing which would be great fun to be involved in. But I was somewhat taken aback by the fact that these hundreds of computer scientists would go out into the world and into computing facilities, probably highly recommended as director types. The 'Establishment' characteristics of the described program seem to me to be quite clearly present: that is, in the program it didn't strike me that he was getting away from the 'Establishment.' I tend to accept this type of description of a computer science program, somewhat more happily, if I think in terms of a computer scientist being quite different from the notion of a computer user or the notion of a person who would be involved in the operation of a facility. The user might be a mathematician, a statistician, a physicist, a businessman, etc., which would involve possibly a type of training quite different from that described here.

Tonge: I would like to raise one question for Dr. Larsen. I would like to get his view on, 'In what way is the training of what we now call customer engineers going to change in the future? At least one of Control Data's competitors has stated that they are going to have the CE responsible for maintaining standard programming systems also. Is the industry in general going this way, and, if so, what other kind of major changes are we going to see that will change the requirements for this class of person?'

Larsen: I think I can safely say that Control Data is definitely going in this direction. The question that remains is how far we can take this customer engineer into the field of programming. The two areas don't always coincide. I think that the type person who finds programming appealing as a career doesn't necessarily find customer engineering appealing. We are starting here with the premise that he must first be a customer engineer and secondly a programmer. We tested all of the several hundred customer engineers we have in the Western part of the United States to determine what abilities or interests they might have in the field of programming. We found somewhat less than 50% of them appeared to have appreciable aptitude in this area. How far we will be able to go I don't know, but ideally we would be much interested in seeing more of them in programming.

Question: Dr. Larsen, how far have you gone in developing the Kuder preference scale for use in selection?

Larsen: Basically we are developing our own scale as opposed to the Kuder scale. Hopefully that will be ready for use in the next three or four months. It will take a year or two before we know whether we are meeting with any success.

Question: I assume from this that you found nothing predictive in the Kuder?

Larsen: Yes, that's correct. Bear in mind that we are talking here of selecting customer engineers and not about selecting people with a good potential for programming. One finding that came as a bit of surprise to us, is the relative lack of importance in this field as far as having mechanical ability is concerned, even though a great many of the peripheral devices in the computing industry are predominantly mechanical or they are certainly half mechanical and half electronic.