DOCUMENT RESUME

ED 092 204 JC 740 196

AUTHOR Oastler, John L.
TITLE Putting the Electronics Curriculum to the Test.
NOTE 49p.

EDRS PRICE MF-$0.75 HC-$1.85 PLUS POSTAGE
DESCRIPTORS *College Curriculum; College Teachers; *Community Colleges; *Curriculum Evaluation; *Electronics; Graduate Surveys; Industrial Personnel; *Institutional Research; Interviews; Post Secondary Education; Questionnaires; School Industry Relationship; Statistical Data; Surveys
IDENTIFIERS *College of DuPage

ABSTRACT

Using both the interview and questionnaire methods, a survey was made concerning the electronics curriculum at the College of DuPage. In addition to institutional objectives related to the survey, other aims of the study were to develop an instrument to determine the professional's concept of a highly trained graduate, to determine whether there existed instructional material seen as important in the curriculum by business, educator, and graduate groups, and to provide data as to improvements in the curriculum suggested by other educators and business people. Interviews were conducted prior to mailing the questionnaire to employers, graduates of the program since 1970, and instructors. Results of the study showed that the instrument did enable recommendations to be made related to the data obtained. A common core of subject matter was determined. The relative evaluations of the three groups surveyed showed no significant discrepancies; there was, however, some difference in the individual item evaluations, with graduates and employers being in close agreement as to what is important in the curriculum. Appendixes provide the Statistical Questionnaire, Comments by Respondents, Rank Order of All Respondents, Rank Order of Instructor Responses, Rank Order of Employer Responses, and Rank Order of Graduate Responses. (DB)

Putting the Electronics Curriculum to the Test*

by
John L. Oastler Ph.D.
College of DuPage

John L. Oastler
Omega College of
College of DuPage
22nd and Lambert
Glen Ellyn, Ill. 60137

*This project was made possible through the services of Omega College of College of DuPage, Mr. Carter Carroll, Dean. The task force, which collected the data and pondered over it, consisted of Patricia Maclachlan, Lewis Raulerson and the author as its chairman. The electronics coordinator, Oley Kuritza, did much in the construction of the questionnaire that enabled the realization of our aims.

If a technical program is administered under the assumption that the more qualified a person is the greater are his opportunities to be initially hired by a prominent company or to be advanced further and quicker in its organization, every attempt should be made to up-grade the curriculum in light of what industry is desirous to have in their employees. Sometimes, a technical curriculum may be perfectly adequate with respect to providing the graduate of the program a sufficient amount of training to be hired by industry and yet not contain information and practice to enable the graduate to do a "better than average" job. It seems reasonable to assume that an employee who performs his tasks efficiently and who seems to know what he is doing in the face of encountering new and different situations will be more highly regarded for his work than those who cannot operate at this higher rate of efficiency.

One may get the impression that community college technical education should simply qualify a person for a job, that no standard of comparative excellence ought to be met in terms of its mission. On the other hand, in the face of a tight job market and consequently, with regard to what industry can demand and often get, it appears that improvement in curriculum should build a program in which the graduateshall better perform his tasks than someone who had no formal education or someone who was educated elsewhere.

The notion of competitive excellence in education is borrowed from what universities have been attempting to do for a long time. The traditional university was dependent upon the support of an active alumni. To assure possessing an excellent reputation, it had to train its graduates to occupy prominent places in the world. The reputation of the university attracted faculty and students alike.

Even though Harvard University was already considered outstanding, its president in the latter part of the Nineteenth Century, Charles Eliot, was bent upon improving its instruction. He introduced the case-study method of grounding the student in the practice of law; and because its graduates of the program were better practicing attorneys, who did not have to be trained "on-the-job," they were in very great demand. In medicine, Eliot introduced a course in comparative anatomy, thinking that a student would come to see human anatomy better by drawing comparisons with other animals. So too, Gilman at Johns Hopkins was convinced that a graduate with training in the use of the scientific method and the methods of research would perform well in nearly every profession, for he would know how to analyze a problem and seek its solution <u>better than</u> one without the background.

Yet in the discussion of accountability of community college instruction to the community, focus has been upon providing evidence for the existence of a program, e.g., an occupational program. In this spirit Moraine Valley Community College in Illinois performed a study to determine whether the graduates of its various technical and vocational areas are meeting the tasks required of them by their employers.[1] The researchers concluded in part that employers were satisfied with the job performance of Moraine Valley's graduates. In conducting the study, Moraine departed from the usual graduate follow-up questionnaire that is sent to merely the graduates, for it asked the employer to rate the graduate-employee on certain skills including technical competence, communication, problem solving and what it construed to be "human relations," e.g., getting along with fellow employees. The study showed that employers in the areas of business, health and public service think highly of the graduates' performance.

Some thought has been given to doing more through the evaluative process than simply determining whether the training received is appropriate to industrial and professional placement. As Angelo Gillie has contended,

> Much more effort is needed in the area of evaluation. Evaluation in many instances has meant nothing more than directing inquiries into attrition rate and whether graduates of a program obtained a position in industry. The contention here is that the use of such devices, with the claim that they are satisfactory methods of program evaluation, is based on shortsightedness on the part of the technical educators.[2]

Gillie advocates a comprehensive procedure of up-dating the curriculum, involving educators and employers, both of whom are to review the curriculum in terms of providing sufficient training for the student to meet certain job requirements and also to move on to other positions. Gillie claims to have used the particular model which he has structurally outlined in his 1969 paper.

Gillie's model calls for a group of professional experts to select topics "deemed appropriate for the technician for the next decade," whereupon the topics are circulated through a survey instrument among employers and educators who train the technicians. The questionnaire is to elicit an evaluation either confirming or disconfirming the chosen topics which the experts think of significant instructional value for years to come.

Whether these particular steps shall lead to up-dating the curriculum is problematic. For one thing, granted that Gillie is right that evaluation should lead to up-dating the curriculum, he has not demonstrated that training the student for an uncertain decade of technological change is a realizable goal, particularly in light of the fact that Gillie is heavily relying upon the intuitions of employers and instructors. In a field like electronics, whose curriculum we were attempting to assess, changes are so rapid that it would make little sense to talk about developments ten years from now.

Moreover, Gillie has yet to demonstrate that training a student for industry should imply that he is henceforth prepared to handle new developments in technology and equipment over the next decade. The community college's function of continuing education should be structured into the curriculum, so that a graduate can acquire further training in the course of his professional career. In addition, an up-dated curriculum will not always produce a better trained employee. We have been told by electronic's instructors that some employers use older equipment, e.g., vacuum tubes, despite the fact that many companies which can shift over to solid-state transistors.

The Gillie model and the Moraine Valley study were useful in our endeavor to fashion a survey instrument that probes to discover areas in the curriculum, which when the student is trained in them, should produce the more competent competitor as the educated person. Both the Moraine Valley researchers and Gillie give prominence to the employers' feed-back. On the other hand, Gillie omits feed-back from the graduates. Offering as the ultimate criterion of evaluation the students' potential in the real world, he nonetheless restricts the evaluation to instructors and employers.[3] We decided to obtain as much feed-back concerning our electronics curriculum as we could: instructors, graduates and employers.

In some respects, Gillie's model goes further in the direction we wish to go than we were able. He proposes that data be collected over a period of time about the students' placement and promotion. We should have liked to stratify our sample of alumni on the basis of the number of years since graduation, the number of promotions or job-change advancements since being employed. While we believe that such data is helpful for thinking through what an employee needs to know in order to be advanced more rapidly than other employees, we think our instrument is able to detect what a priori ought to be of value to the graduate with regard to job mobility as well as in obtaining initial employment. In light of the data about the graduates we were able to collect from the available records, our study is designed to provide information concerning what seems most useful to the employer, to the graduate on-the-job, and to the graduate enrolled in a B.S. degree technology program at a university. We are assuming that what appears important training to people in business can give insight into the characteristics of an excellently-trained, competitive technician.

Gillie adds a "precaution" that is written into our evaluative procedure. He urges that the technical instructors of the community college program play a significant role in the construction of the instrument of assessment. Since some change is expected as a result of the study, it is more likely for change to occur whenever the instructors are involved in doing the study. It should be more understandable to them. They know better than we the technical language, and they know how to interpret the comments pertaining to the electronics curriculum made by other technical people. In this way, the evaluator is a facilitator of communication between the community college's instructional staff and the professional world.

Purposes of this study

There were institutional goals in the study. (1) The College is currently under-going a self-appraisal of its manifold curriculum. It was anticipated that our study would produce information that would be of value to at least one such program, that of electronics. We were also hopeful that t.. observations we made in the area of electronics could be significant in analyzing other programs at the College. (2) We wanted an instrument that would advertise the College. Believing that community involvement in the affairs of the College will strengthen supportive ties with the citizenry, we were concerned to enhance the College's image to the community. (3) The state's Division of Vocational and Technical Education had evaluated the occupational education program of the College the year before our study commenced. Its report appeared to many of us of the College to be general and vague in its comments. By considering in some detail the curriculum of a particular occupational program, we intended to come up with recommendations that seem warranted by the data we collected. Moreover, their report cited the "potential resources" of the College of DuPage community, which they implied were not being tapped. Our study aimed to discover whether such resources existed by asking industry directly whether it would be willing for the College to utilize the company's equipment in an intern program with the College.

In addition to institutional goals were the theoretical aims discussed above. (1) We wanted an instrument that would provide indication concerning what the professional would regard as a highly trained graduate. Following the lead of Charles Eliot, we, too, assumed that an individual who is intensively trained in the useful material for job performance will a) need less on-the-job training, less overseeing and b) prove himself of greater worth to the profession. There are those educators who disagree concerning the philosophy implied by this goal. They contend that the technical educator should not become enslaved by the entrepreneur. This led us to the second theoretical goal: we wanted to determine whether there could exist a common set of subject matter material which all three groups--business, educator, graduate--could agree upon is important for the student to learn. Conversely, we were interested in laying bare the areas of disagreement over what should be in the curriculum. (3) We wanted to provide data, not heretofore given the educator, about how other educators and how business people think our College's electronics curriculum could be improved. Obviously, many people related to the educative process have given some time to thinking over what they would like to see taught. Perhaps, some of the layman's ideas are not useful to the educator in improving his curriculum, but at least the educator should be aware of the thoughts of those who are either working in industry or hiring, if our program is to be meaningful to the world outside of education. In other words, by asking the professional to comment on how our program might be improved, we were attempting to establish the groundwork for a continuing dialogue between industry and education.

Procedures

Both the interview and questionnaire methods were utilized to obtain data concerning the electronics curriculum. The data from the in-depth interviews was coded into the statistical questionnaire on the basis of the verbal replies.

(1) Meeting with the coordinator of the program, Mr. Kuritza, the task force established to conduct the study, composed of John Oastler, chairman, Al Raulerson

and Patricia Maclachlan, designed an open-ended response instrument which presented the core of topics making up the curriculum. The members of this task force were chosen largely on the basis of their interest and professional training. One member, who has had some experience in curriculum design at the elementary school level, Dr. Maclachlan, was paid but only for the interviews she conducted. The other two members, Drs. Oastler and Raulerson, were enrolled at the time in administrative training programs at near-by universities.

(2) The in-depth interviews obtained feed-back concerning the possibility of doing the study in the topical form that the questionnaire had. Interviewed was one instructor, who is also the coordinator of a university technology program into which some of our graduates go, three employers who could, or do, hire graduates of an electronics two-year program, and five of our graduates, two of whom are now receiving additional technological training at the university level. The number of interviewees was arbitrary, although we wanted to get "a feel" for the instrument before we sent it out in a printed version. Particularly, we were interested in assuring ourselves that the questions were understandable and that the respondent could "catch on" as to what was being asked him. As a result of the interview process, certain changes in the printed questionnaire

were made to facilitate the answering process, so that the respondent could readily take the questionnaire without needing someone to interpret what was being asked him. The questionnaire is long and technical. After interviewing 9 people, we had gained sufficient assurance that the instrument was understandable and was yielding significant data.

(3) The task force then constructed a statistically analyzable questionnaire with opscan answer sheet. (see Appendix A). The questionnaire was mailed to 43 businesses. Initial selection of the employers was 34 names taken from a listing of job opportunities in electronics through the employment center of the College, but when 4 of these responded that they do not hire electronics graduates, and thus did not feel qualified to answer the questions posed them, the task force obtained an additional listing of 9 employers from the coordinator. No attempt was made to elicit comments about any particular employee's job performance and none were received. Since the questionnaire centers about the material of the curriculum, it could be sent to persons unfamiliar with the College's graduates or our program. The questionnaire sent to the employers was addressed to the business, although every effort was made to identify a person who could fill it out. Twenty-five employers responded.

Every graduate of the program since 1970 was sent a questionnaire--61 in all. The program is relatively new, as is the College of DuPage, and admittedly, we would have liked to have had a larger sample with which to work. Added to our frustration over the limited number of graduates and the year-span with which we dealt was the difficulty in reaching a significant portion of the graduates. Apparently, many have moved away, but even so, thirty graduates responded.

Instructors were also contacted through the mail. The Associate Dean of Instruction of the College, who has been in charge of the technical programs, suggested that 3 state univerities who run transfer programs in electronics or related areas, e.g., industrial arts technology, be contacted. The task force also included the coordinator from a neighboring community college. Thirteen instructors were sent the questionnaire and eight responses were received.

Importantly, in addition to registering an evaluation concerning the usefulness of the topical item, the respondent was encouraged to make whatever comments he wished. He was specifically asked to suggest ways to improve upon the current curriculum.

Data and Analysis of Comments

The comments obtained from the questionnaire are appended (Appendix B). They are grouped by responding source--employer, instructor and graduate. These are faithfully reproduced in summary form; and the respondent's identity is withheld except with respect to grouping. The comments give the impression that there is no important difference between those offered by employers and those of the graduates.

Changes that seem overwhelmingly indicated in terms of the comments are: (1) The graduate should obtain a practical, "hands-on" education. Attention upon trouble-shooting is insisted upon by both employer and graduate. Comments 10, 40, 48, 53, 71, 94, 104, 116 support the contention that industry wants troubleshooting experience. Many point out the need for a thorough grounding in the lab experience: 4, 6, 8, 17, 19, 21, 47, 57 (which reports need for simulation of real situations in the lab), 71 (which advocates trouble-shooting in the lab), 88, 109. Moreover, a few of the graduates' comments point to the usefulness of yet more application of the material than what they received, e.g., 4, 6, 88, 100, while two comments from the same employer note that he is dissatisfied over the degree of application his employees in electronics come with, 13, 17.

A few comments indicate that the well-trained person should know how to schedule his time appropriately: 15, 110.

(2) The curriculum should provide the student with intensive mastery of a specialized area in electronics. Among the items providing one with this impression are: 7, 20, 23, 41, 51, 61, 66, 70, 72, 85, 91, 109, 111, 115.

Moreover, over 40% of the graduates' comments from 24-94 identify particular topics that more time should be spent upon. Some of these comments are insightful concerning the reason why graduates feel the need: "Digital circuits rushed through when very important, like learning a foreign language" 72; "Two quarters on digital theory at least," 49. Unquestionably some graduates are presently experiencing frustration due to the need for a greater amount of knowledge in a specific area of electronics.

(3) Technological shifts indicate the curriculum structure should amply cover the new modes, insofar as the graduate will probably need to know them. Looking at the electronics program as a whole in terms of curriculum, certain respondents envision greater coordination with other programs, e.g., computer programming, 18, 22, 105, and related skills, e.g., the use of light sensitive devices, 70, 121. The comments point out certain concepts are being phased out of some areas in industry: vacuum tubes in favor of solid state, 29 etc., direct current meters in favor of digital multimeters, 107, tunnel diodes and thermal stability in favor of silicon devices, 118, thyratons, 119, core in favor of semiconductors, 123, and relay logic.

The number of comments concerning digital circuits suggest that the curriculum should emphatically stress training in that area. Some comments by the graduates indicate that a course in solid state electronics would be useful, 43, 61, 65, 71. Other areas which, the graduates' comments lead one to believe ought to be treated in fuller detail: instruction in semiconductors 36, 74, 77, 90; instruction in item #11--the concept of impedance; j-operator and complex numbers; polar and rectangular forms; phasors--51, 76; and instruction in the use of integrated circuits, 38, 42, 52, 60, 67, 69, 87. Graduates' comments also indicate more intensive study should be available in audio, TV electronics; 32, 52, 71, 91.

Industry comments that the graduate who has training in business practice is more valuable to the business, 14, 16, 17, 103, 117.

Comments by the employer indicate that industry insists upon additional formal training for their electronics employees. One employer remarks that he uses a programmed course to teach semiconductor material, 97. In terms of the comments of the graduates, including those dealing with the program as a whole, one is led to think they, too, believe they must seek more schooling.

Some suggestions question whether the program should cover as much as it does, if it is aimed to train electronic technicians, 4, 12, 23, 121. Articulation over curriculum with four-year programs, which lead to the B.S. degree in electronics technology, is suggested. Firstly, there is a question concerning what should be taught at a community college as opposed to a four-year college, 12, 23, 35, 106, 127, 130, 131. Secondly, there is a question over the possibility of facilitating transfer to senior programs in electronics, 24, 134. It may be possible through articulation to shorten the time the graduate must spend in a senior level program or it might be feasible to readily identify those community college students who should go to a senior institution earlier in their college career.

The results from analyzing the comments provided a "key" with which to proceed in interpreting the statistical data. Assuming that the comments emphasized what in fact the statistics were saying, the experimenters used the impressions gained from the comments to organize the data of the questionnaire presented below.

Analysis of the Questionnaire Results

(1) It is well substantiated that some topical material is regarded by each responding group--instructor, employer and graduate--as being essential to the program. A remarkable concurrence in the rank ordering of each group is evident. 13 of the 15 top items, i.e., the upper half, as ranked by the employers appear in the top 15 listing of either the graduates or the instructors. While each group differs as to the particular value assigned to the items, there is noticeable similarity in the relative value given to the items.

Fourteen items have a mean above 3 and a standard deviation below 1.00 for all persons responding, namely, the item headings

basic principles of direct current
resistors and batteries
basic principles of alternating current
inductance topics
capacitance (capacitors, capacitive reactance)
time constants
resonance
filters
semiconductors
amplifiers
power supplies
special active devices (integrated circuits, etc.)
pulse circuits
instrumentation--basic meters; a-c measurements, etc.

Of these, seven are shared by every group, namely,

basic principles of direct current
basic principles of alternating current
capacitance
time constants
filters
semiconductors
inductance

Because every group concurs in thinking these seven topics are important, we believe they should be considered as basic material to the program.

Comments given by graduates tend to support the contention that more instruction would be helpful in certain of the above seven topics, namely, filters, time constants and semiconductors. With respect to the fourteen items cited above, the topics, resistors, integrated circuits, and instrumentation are added to the list of areas which graduates have urged for more instruction in.

All three groups apparently think the following topics bear little significance to the subject matter, when by "little significance" is meant statistically those topics with 2.25 or less mean,

vacuum tubes
microwave
transmitters
antennas and transmission lines

In addition to believing these insignificant topics, employers cite the following:

R-F circuits
oscillators
modulation
receivers

Employers apparently do not have much need for persons trained in audio electronics.

In instructing all students of the program, those bearing little significance for every group might be covered in cursory fashion. Those students who are going into industry may do well to avoid intensive training in the additional topics which the employers noted have little value in industry.

(2) Instructors seem to share the overall opinion that the curriculum material is useful. Of 30 topics listed, 20 are given a mean 3 or above.(Appendix D). Graduates place 16 of the 30 topics at 3 or above.(Appendix F). Employers put only 13 of the 30 in this category.(Appendix E).

We have already pointed to the similarity among the three groups in ranking the upper half items. Congruence of items placed in the 21-30 positions among the three groups is nearly achieved: 8 of the 10 items appear on every list; and 9 of the 10 topics ranked by the employers re-appear on the graduates' list. In terms of the phenomenon of similarity of ranking of each group, it should be possible to structure a curriculum that emphasizes what employers want in a graduate.

(3) It is clear that some material in the program has use for some persons and little use for others. This finding should be expected for any program, since a program's objective is, in part, to provide an overview of the subject as well as to give opportunity for growth in a specialized area.

To determine what is valuable for some but not all, we have interpreted the topical items with below 3.00 mean but having an S.D. above 1.00 to fall into this category. Thus, the employers' responses put the following topical items into this class: 4, 6, 12, 18, 19, 21, 22, 23, 24, and 28; while the graduates' responses make the following: 4, 6, 12, 13, 17, 18, 19, 20, 21, 22, 23, and 24. Common to both of these are 4, 6, 12, 18, 19, 21, 22, and 24; or respectively,

conductors and insolators
magnetism and electromagnetic induction
resonance
R-F circuits
oscillators
modulation
transmitters
receivers

In that the above topics are seemingly important for only some of our graduates, who are placed into industry that use such equipment, it should be possible to structure these topics into the curriculum through an elective system, offering courses in the program as electives or giving intensive instruction on an optional basis, so that those students who are not interested in the material above would have a mere general knowledge about them, while those who need a greater degree of knowledge could obtain it.

Of the above list common to both employer and graduate, the instructor group concurs on items 4, 18, 21, 22 and 24.

Program Recommendations

In light of the findings of the experimental study and with reference to the requirements for an A.A.S. degree in electronics, the task force urges that the program should be improved along the lines proposed below in order that the College's electronics graduates shall prove more valuable to industry. While these recommendations do not directly pertain to the topical subjects, implementation of change along the lines to be suggested are based upon the above findings.

1. In that the graduate could use intensive training in an area of electronics, the task force recommends an internship arrangement with industry. Those graduates who now believe that they need greater preparation in some particular area in the vast field of electronics might have

made this discovery earlier through an intern program. They might have acquired greater depth in a specific area, if they had participated in an intern program. Employers also have pointed out that they prefer technicians with some job experience.

When through the interviewing we found that the graduates felt concerned over the lack of depth achieved in training offered by the College, we added to the curriculum questionnaire sent to the employer a question about whether his firm would participate in an intern program or whether he knew of firms that might. We found 5 companies interested and 11 firms were named. The coordinator of the electronics program is currently making inquiry into a number of these.

Knowing how to use various equipment, to trouble-shoot, to handle the real situations are seemingly the aims of the serious student. How best can he meet these unless he is given the opportunity?

In an intern program, the student would select an area of specialty. The interning would begin in the second year, after the student has been grounded in the basics through a survey of the entire field in the first year of study.

2. Electives should be kept to a minimum. Since apparently not enough material is provided the graduate, the set of priorities concerning what can be taught and how much of a topic can be covered should be revised by the

technical instructors. Their professional judgment may necessitate cutting back the number of electives now permitted.

It may be possible for the College to offer "mini-courses" in the humanities to the tech students, whereby the student is introduced to a humanities subject through smaller "chunks" of an ordinary course. Along these lines, the task force learned through conversation with some instructors from Miami-Dade Community College that they offer a general humanities course composed of three separate disciplines split into course segments. A member of the task force in touch with Sangamon State University reported that philosophy is taught to vocationally-oriented university students by relating the material of the discipline to their vocational, as well as personal, interests.

3. The basics as determined by what respondents overwhelmingly consider either very useful or frequently useful irrespective of group identification (instructor, graduate, or employer) should form the nucleus of a first year program in electronics. Since respondents indicate the importance of these topics no matter which area of electronics technology they are concerned with, it is important that every student should know them thoroughly.

The second year could be devoted to the student's development in some special field, e.g., audio electronics or power supplies. Even without an intern program, it is recommended that the student be given the option to specialize.

4. Additional courses should be developed to reflect the degree of intensive study requisite for efficient handling of the varied job tasks in the field. Possibly, a required course should be offered in each of the following areas: power supplies, semiconductors; integrated circuits; and perhaps two courses in digital circuits (instead of the one currently given).

It is further recommended that elective courses be developed in each of the following: audio electronics; computer electronics; sophistical electronics (built around light sensitive devices).

If courses cannot be implemented, seminars for credit should be instituted. Perhaps, too, the existing courses can be structured in such a way as to emphasize the concerns of the graduates and employers, in particular, as herein recorded.

5. A continuing education program should be instituted. At present, the employed graduate has learned enough to get hired, even though he may feel the need for additional training. It is likely that he will enhance his opportunity for job mobility and advancement upon receiving additional training.

6. With regard to previously expressed concerns, it is recommended that articulation be instituted among the several schools offering programs in electronics, including the high school and the university. Some of the instructors contacted appear interested in articulation, e.g., those at Western and at Northern Universities.

While the primary emphasis of a technical program is not transfer, for those who might want to pursue additional training at the university level or for those who wish to pursue their training at a university, the College might facilitate transfer through articulation.

Conversely, counseling at the end of the first year in the program should inform the student of the educational options available to him. According to some instructors from neighboring universities who responded, the first year of our curriculum appears wholly transferable, but not all of the second year's.

Evaluation of this study in light of its purposes

The study is establishing lines of communication with the industrial community. Currently, the electronics coordinator is getting in touch with employers who have indicated a willingness to inaugurate an intern program. Further, the electronics instructors have appreciated information about the curriculum they currently offer. They have said that some changes in curriculum are presently being contemplated.

Significantly, the instrument did enable us to make recommendations in light of the data we found. A common core of subject matter material was un-earthed. We did not discover an unusual amount of discrepancy in the relative evaluations provided by the three groups, although there appears some difference in the individual item evaluations: instructors rate much higher, employers much lower; but both instructors and employers rank the items similarly. Graduates and employers appear much closer in their understanding of what is useful.

The simple instrument we used, we believe, prompted comment by virtually laying the curriculum bare. The length of the questionnaire is formidable. On the other hand, we discovered that the respondents were apparently interested enough to participate in the survey. The instrument should be valuable in studying the curriculum of any topically-oriented subject matter.

BIBLIOGRAPHY

1. Lynn H. Willett and William E. Piland, "Employer Evaluation of Occupational Programs," paper presented at the annual American Educational Research Association convention at Chicago, Illinois, April, 1974.

2. Angelo C. Gillie, "Six Roles for the University," _Junior College Journal_, 39, no. 7, April, 1969, p. 34.

3. _ibid._, p. 36.

APPENDIXES

Appendix A: Statistical Questionnaire

DIRECTIONS FOR EMPLOYER'S QUESTIONNAIRE

TO FILL OUT THE OPSCAN SHEET, FOR EVERY CLUSTER OF CONCEPTS, SELECT AN EVALUATION OF THE FOLLOWING THAT IS MOST EXPRESSIVE OF YOUR REACTION TO THE ENTIRE CLUSTER -- a) VERY USEFUL; b) FREQUENTLY USEFUL; c) OCCASIONALLY USEFUL; d) NOT USEFUL AT ALL; e) CAN'T JUDGE.

Use a number 2 pencil. Mark your answer concerning the usefulness of each of the cluster of concepts.

You will note that following every question is room for your comments concerning the cluster or any concept of the cluster. Place comments in the space beneath each question. Continue on back of the questionnaire if you need to noting the question to which the comment refers. It is important to fill out the opscan sheet in addition to whatever comments you wish to make on the questionnaire sheet.

USE THIS ANSWER SELECTION FOR MARKING 1-30.

DIRECT CURRENT

1. Basic principles: (structure of matter; charge, voltage, current resistance; Ohm's Law; series, parallel and combination networks)

2. Network Laws: (solving networks by branch currents; Kirchhoff's Laws; Thevnin's Theorem; Norton's Theorem; Superposition Theorem; Maximum Power Theorem; Delta-Wye Transformation)

3. Direct Current Meters: (moving-coil meter; meter shunts and multipliers)

4. Conductors and insulators: (standard wire gage sizes; types of conductors; switches; fuses and lamps; wire resistance; temperature coefficient; ion current; insulators, dielectric strength, corona)

5. Resistors and Batteries: (types ratings, color code of resistors; thermistors; batteries)

2. Employer

6. Magnetism and Electromagnetic Induction: (basic units; types of magnets; Hall Effect; Permeability and hysteresis; magnetic field and electric current; Lenz Law; Faraday's Law and motor action)

ALTERNATING CURRENT

7. Basic Principles of: (The Sine Wave; Frequency, period, wavelength, phoseangle; harmonic frequencies)

8. Inductance: (self-inductance; mutual-inductance; transformers and chokes)

9. Capacitance: (capacitors; capacitive reactance)

10. Time constants: (capacitive; inductive)

11. Impedance: (concept of impedance; j-operator and complex numbers; polar and rectangular forms; phasors)

12. Resonance: (series and parallel resonace; Q-factor; tuning)

13. Filters: (low-pass, high-pass, resonant filters; interference filters; transformer and capacitive coupling)

BASIC ELECTRONICS TRAINING

14. Vacuum tubes: (emission; construction and types; ratings and characteristics)

15. Semiconductors: (P and N types, doping; PN junction; semiconductor diodes, types and characteristics; transistor operation; biasing; types, ratings, characteristics of transistors; load-line analysis; thermal stability; equivalent circuits; zener diodes; tunnel diodes)

3. Employer

16. Amplifiers: (types and classes; coupling, load lines; cascading, direct coupled amplifiers; gain calculations)

17. Audio circuits: (preamplifiers; push-pull amplifiers; phase splitting; feedback and regeneration: distortion, stereo; microphones and speakers)

18. R-F circuits: (single-tuned; double-tuned; stagger-tuned; wide-band circuits; wave traps)

19. Oscillators: (tickler-coil; Hartley and Colpritts; crystal oscillators; phase-shift oscillators)

20. Microwave: (resonant lines; cavity resonators and waveguides; magnetrons and klystrons; traveling-wave oscillators; lasers and masers)

21. Modulation: (principle of modulation, sidebands; A-M, F-M; plate and control-grid modulation; single-sideband)

22. Transmitters: (R-F stages and power stages - neutralizing, frequency multipliers)

23. Antennas and Transmission Lines: (principles of radiation; Dipole Theory; antenna types; radio-wave propagation; transmission lines)

24. Receivers: (detection; superheterodyning; AVC; limiters and discriminators; AM, FM stereo multiplexing; communication receivers; television receivers)

APPLIED ELECTRONICS

25. Power supplies: (power transformers; rectifiers; voltage-doublers; filters; voltage regulators)

26. Special Active Devices: (gas tubes and thyratrons; SCR; UJT; FET; light sensitive devices; integrated circuits)

4. Employer

27. Pulse Circuits: (pulse generation; relaxation oscillators; multi-vibrators; timing circuits; wave shaping; differentiators and integrators; Schmitt Triggers)

28. Digital Circuit: (binary and octal number system; Boolean algebra relay logic; logic gates; binary counters; shift registers; feedback counters; encoding and decoding matrices; magnetic core memory)

29. Instrumentation: (basic meters; a-c measurements; comparison measurements; bridge measurements; VTVM; recording systems)

30. Instrumentation (Continued): (transducers; oscilloscope; signal generators; component test methods; R-F test methods; square-wave testing)

<u>Questions 31 and 32 are not to be answered on the opscan sheet</u>

31. In the light of your experience, is an appropriate theory useful to the employee in making the transition from working with one electronics machine to working with another?
a) very useful; b) frequently useful; c) occasionally useful; d) not useful at all

32. Would your company or do you know of companies that might be willing to accept our students as interns to learn on the company's electronic apparatus, providing we could make an attractive offer? a) yes; b) no

Please list firms we could contact:

33. Kindly list materials and subject matters you believe our curriculum ought to contain but does not:

Thank you for your assistance. College of DuPage is interested to improve its quality of instruction. Your aid is truly appreciated.

5. Employer

COLLEGE OF DuPAGE

EMPLOYER QUESTIONNAIRE - Electronics Program Survey

Kindly list the job descriptions of positions in the electronics area for which you are hiring or regularly hire for which our graduates could probably compete.

Graduate's Questionnaire is the same as employer's except for changes marked by asterick below.

4. Graduate

27. Pulse Circuits: (pulse generation; relaxation oscillators; multivibrators; timing circuits; wave shaping; differentiators and integrators; Schmitt Triggers)

28. Digital Circuits: (binary and octal number system; Boolean algebra; relay logic; logic gates; binary counters; shift registers; feedback counters, encoding and decoding matrices; magnetic core memory)

29. Instrumentation: (basic meters; a-c measurements; comparison measurements; bridge measurements; VTVM; recording systems)

30. Instrumentation (cont'd): (transducers; oscilloscope; signal generators; component test methods; R-F test methods; square-wave testing)

<u>Questions 31-36 are not to be answered on the opscan sheet</u>

**31. In light of your present experience, is the theory you have learned useful to you in making the transition from working with one electronics machine to working with another? a) very useful; b) frequently useful; c) occasionally useful; d) not useful at all

**32. Do you feel that you learned material that has no direct application in your job? a) yes, far too much; b) yes, a bit too much; c) no

**33. Are you thinking of more schooling in electronics? a) yes, in a few years; b) yes, I am going to school now; c) yes, but far off in the future.

**34. Was the material you learned at C/D related to job performance? a) most of the time; b) frequently; c) occasionally; d) rarely

**35. Was the material you learned in the lab related to troubleshooting activities, i.e., what to do when the machines break down? a) most of the time; b) frequently; c) occasionally; d) rarely

5. Graduate

**36. In light of your job tasks and your career objective, in what areas do you want to improve your skills?

37. Kindly list materials and topics you believe our curriculum ought to contain but does not.

Thank you for your assistance. College of DuPage is interested to improve its quality of instruction. Your aid is truly appreciated.

6. Graduate

COLLEGE OF DuPAGE

*GRADUATE QUESTIONNAIRE - Electronics Program Survey

**Give present job description of your activities in your own words, please.

If you are attending another school presently, please tell the program you are enrolled in, your career objectives and the courses you are taking.

Instructor's Questionnaire is the same as employer's except for changes marked by asterick below.

4. Instructor

26. Special Active Devices: (gas tubes and thyratrons; SCR; UJT; FET; light sensitive devices; integrated circuits)

27. Pulse Circuits: (pulse generation; relaxation oscillators; multi-vibrators; timing circuits; wave shaping; differentiators and integrators; Schmitt Triggers)

28. Digital Circuits: (binary and octal number system; Boolean algebra; relay logic; logic gates; binary counters; shift registers; feedback counters, encoding and decoding matrices; magnetic core memory)

29. Instrumentation: (basic meters; a-c measurements; comparison measurements; bridge measurements; VTVM; recording systems)

30. Instrumentation (cont'd): (Transducers; oscilloscope; signal generators; component test methods; R-F test methods; square-wave testing)

<u>Questions 31 and 32 are not to be answered on the opscan sheet</u>

** 31. What material should be added to strengthen and improve our electronics program?

** 32. For those students in our program who wish to transfer to your college to continue the study of electronics, what training would be necessary to make the transition?

Thank you for your assistance. College of DuPage is interested to improve its quality of instruction. Your aid is truly appreciated.

APPENDIX B

COMMENTS ON ELECTRONIC CURRICULUM BY RESPONDENTS

(identification of respondents is subject to error upon occasion)

GRADUATES

Respondent's*	No.	Overall Comments
1	1	useful overview given
2	2	part-time instructors can't communicate as well
3	3	much learned not learned at C/D
4	4	too much time spent of material having no direct application
5	5	need gen. ed. courses for transfer
6	6	more schooling, didn't learn enough which is applicable
6	7	more intensity, depth
7	8	need more time in lab
8	9	make deliberate tie-in of material to science courses
7, 9, 10	10	need more troubleshooting activities
	11	theory very useful

EMPLOYERS

Respondent's*	No.	Overall Comments
11	12	looks like 1/2 of a 4 yr. tech. program but not hiring an engineer
11	13	not teaching the individual the equipment he will actually need to learn
11	14	the grads. don't understand what a company is and yet they work for a company
11	15	they are not taught to schedule their time, to work on their own
11	16	should have seminars with industry for purpose of acquanting with industry
12	17	students would learn best if they began with practical courses and filled in physics later--"Students who start college without working experience have no frame of reference by which to evaluate formal courses on field theory etc., and therefore do not retain it."

*I.D. No.

APPENDIX B (con't)

EMPLOYERS (con't)

Respondent's*	No.	Overall Comments
12	18	microprocessors and programmable ROM are rapidly becoming a cost effective for medium to high production logic designs. Students should at least be exposed to basic processor techniques
		INSTRUCTORS
13	19	nothing included about lab work, soldering, dressing wires nor about wire sizes, types, about motors, generators, house-wiring. Nat'l. electric code--all important to industrial arts
14	20	doing a good job if you can cover it all
14	21	emphasize lab experience, hands-on
14	22	relate to computer programming
15	23	cover topics numbered 1-17 thoroughly, do not try to cover it all, some of which is jr./sr. yr. material
16	24	graduate could transfer to IIT as Jr. if has diff. and integral calculus, some diff. equations
		STUDENTS
		Comments on Additional Training by Graduates
1	25	need more schooling after C/D
9	26	at school in Tel. Co.
4, 7, 17, 18, 19, 20	27	indicated more schooling needed or desired
21, 22	28	more schooling sought in specific areas

*Respondents identification number

APPENDIX B (con't)

AREAS WHERE IMPROVEMENT IN CURRICULUM MIGHT BE USEFUL

Respondent's	No.	According to Graduates
9	29	vacuum tubes hardly useful because of solid state
3	30	include study of solid state electronics
3	31	semiconductor films need updating
10	32	audio circuits inadequate treatment of
10	33	conductors more use to electrician
10, 17	34	no need for tubes, at least less time upon
17	35	micro-wave too specialized for 2 yr. program
23	36	semiconductors need more emphasis less on vacuum tubes
23	37	more time on network laws
23	38	more time and work with SCR, UJT, FET and integrated circuits
24	39	resistor and megnetism covered too quickly
24	40	more troubleshooting and testing
25	41	greater depth in digital circuits
25	42	logic integrated circuits
25	43	solid state electronics needed
25	44	digital computer theory
25	45	transistors and solid state devices
26	46	advanced digital circuits belongs in curr. and circuit designs
26	47	build a circuit in lab
27	48	analog circuits troubleshooting
27	49	two quarters of digital theory at least
27	50	use of oscilloscope
4	51	more on the basic principles, e.g., impedance
4	52	more on zener diodes, audio circuits, lasers, linear amps, integrated circuits, but cut out pulse circuits, load lines, equivalent circuits
28	53	troubleshooting emphasized
28	54	less tube theory
9	55	design in IC and transistors, filtering and noise problems
9	56	AC power equipment use (transformer, multi-phase)
29	57	lab should be set up to simulate various conditions as electronic controls subject to working conditions

APPENDIX B (con't)

Respondent's	No.	What to improve upon in curriculum: Graduates' opinions (cont'd)
6	58	digital circuits
6	59	base 8 logic is a must for HP computers, Teradyne computers, and digital computers
30	60	IC's need emphasis
17	61	more emphasis upon audio electronics
17	62	digital theory and equipment
31	63	loop and node analysis
31	64	block-box theory
32	65	solid state theory more on
32	66	more TV electronics
33	67	integrated circuits, network laws
34	68	theory of telephony carrier and data mission
20	69	integrated circuits
20	70	should offer entire course in sophisticated electronics: light activated transistors, read only memories, etc.
35	71	troubleshoot in real situations with tvs and radios
35	72	digital circuits rushed through when very important, like learning a foreign language
21	73	loop and node analysis is important to stress
21	74	semiconductors need stressing
22	75	wye and zee matrix
22	76	impedance inadequate treatment
22	77	improve semiconductors instruction--never did a biasing; this could have been done at C/D
22	78	zener diodes and tunnel diodes, more on
22	79	J-Operators needed directly
22	80	Carnaugh mapping would have helped
22	81	digital circuit, insufficient course
36	82	phase angles used in time constant work
36	83	filter material principles not covered at C/D
36	84	need extensive use with variety of integrated circuits
36	85	more material on power transformers
36	86	ignatrons are important, not obsolete, as is thought at C/D!

APPENDIX B (cont'd)

Respondent's	No.	What to improve upon in curriculum: Graduates opinions (cont'd)
36	87	need study of terms in integrated circuits
36	88	more useful to have application of instruments in simulated test situations
37	89	circuit analysis course should include calculus
37	90	application of semiconductors, amplifiers
37	91	audio circuits has proven difficult--not enough lecture and time spent upon
37	92	limiters and discriminators in receiver, more time on
37	93	digital circuit text was poor
37	94	relate coursework to troubleshooting
		What to improve upon in curriculum: Employers' opinions
11	95	teach basics in lab setting, not from math background
11	96	need knowledge of temp. measurement and thermocouples used in industry
11	97	need semiconductor training--Career Center for Tech. development has up-to-date programmed course in digital electronics
11	98	relevancy of audio circuits and R-F circuits questioned for industry, specifics aren't relevant
11	99	too much time devoted to communication electronics worth only 1-1/2 months study
11	100	communications core could be more practical
11	101	digital circuit application needs strengthening
11	102	"instrumentation" (#s 29 and 30 of questionnaire) should not be at end but after vacuum tubes
11	103	should have business training
11	104	should have training on basic equipment and standard problems concerning

APPENDIX B (cont'd)

Respondent's	No.	What to improve upon in curriculum: Employers opinions (cont'd)
38	105	include some programming, Fortran, Basic computer architecture
38	106	make mandatory course in college algebra
39	107	direct current meters being replaced by digital multimeters
39	108	R-F circuits and oscillators used in carrier work
40	109	spend more time on labs
40	110	have students learn to work on their own, schedule their own time
42	111	strong emphasis needed on integrated circuits
42	112	designing with IC's, both digital and linear
42	113	develop use in operational amplifiers
43	114	digital circuits very important
43	115	need more circuit analysis
43	116	need much practice in troubleshooting techniques
44	117	need overview of the telephone industry, stressing various uses of electronic equipment, etc.
12	118	tunnel diodes and thermal stability little used since silicon devices are almost universal
12	119	gas tubes and thyratons not used anymore
12	120	triacs used as much as SCRs
12	121	light sensitive devices continuing to increase in importance
12	122	include hexadecimal number system
12	123	semiconductor memory is replacing core
12	124	don't teach relay logic
41	125	FM 2-way communication needed
		What to improve upon in curriculum: Instructors' opinions
42	126	digital circuits should be stressed
42	127	should have good math and physics training
42	128	need differential equations in electricity and magnetism work
15	129	conductors and insulators belong in h.s.

APPENDIX B (cont'd)

Respondent's	No.	What to improve upon in curriculum: Instructors' opinions (con't.)
15	130	impedance firmly anchored in basic sci. and applied math. necessary
15	131	filters only a smattering at 2 yr. level
16	132	emphasize feedback concept
16	133	power stability of network, Router-Horovitz-Nyquist stability criteria should be covered
43	134	develop cooperative program to transfer in engineering tech. to 4-yr. college
44	135	strengthen integrated circuits, digital circuits

Please remember, there may be a discrepancy between the comments made and the individual who is claimed to have made it.

APPENDIX C

RANK ORDER OF QUESTIONNAIRE RESULTS, 63 RESPONDENTS INSTRUCTORS, EMPLOYERS AND GRADUATES

	Item	A*	B	C	D	Mean	S.D.
1.	1	81	10	3	2	3.72	.76
2.	7	79	8	8	2	3.65	.83
3.	9	63	21	13	0	3.52	.72
4.	15	67	17	10	5	3.48	.86
5.	8	59	21	17	0	3.43	.78
6.	25	62	21	14	2	3.40	.91
7.	29	56	27	8	6	3.36	.90
8.	10	54	22	14	5	3.32	.91
9.	30	59	22	5	10	3.31	1.06
10.	26	46	33	11	5	3.27	.86
11.	28	52	21	11	10	3.24	1.02
12.	5	44	37	13	5	3.23	.86
13.	27	44	32	16	3	3.23	.85
14.	2	48	16	24	6	3.12	1.02
15.	16	38	32	22	5	3.07	.91
16.	11	41	24	19	10	3.03	1.03
17.	13	38	29	25	3	3.02	.97
18.	12	38	25	27	3	3.00	.99
19.	3	35	25	35	2	2.97	.89
20.	6	35	25	22	11	2.90	1.05
21.	17	29	30	30	8	2.77	1.01
22.	4	27	25	27	13	2.68	1.09
23.	19	22	19	37	19	2.46	1.06
24.	18	21	21	30	19	2.43	1.11
25.	21	21	24	25	25	2.42	1.11
26.	24	24	21	25	24	2.39	1.20
27.	22	13	27	25	30	2.16	1.10
28.	14	10	19	33	33	2.05	.98
29.	20	11	17	30	32	2.02	1.07
30.	23	14	21	24	33	2.00	1.20

Standard deviation ranged from low of .76 to high of 1.20.

*% answering A,B,C, or D. Effort was made not to tabulate "E" responses in the above.

APPENDIX D

RANK ORDER OF QUESTIONNAIRE RESULTS, INSTRUCTOR RESPONSES

	Item	A*	B	C	D	Mean	S.D.
1.	1	100	0	0	0	4.00	.00
2.	7	100	0	0	0	4.00	.00
3.	8	75	13	0	0	3.86	.38
4.	15	75	13	0	0	3.86	.38
5.	9	75	13	0	0	3.86	.38
6.	11	63	25	0	0	3.71	.49
7.	12	63	25	0	0	3.71	.49
8.	16	63	25	0	0	3.71	.49
9.	17	63	25	0	0	3.71	.49
10.	6	63	13	13	0	3.57	.79
11.	10	50	38	0	0	3.57	.53
12.	2	50	38	13	0	3.38	.74
13.	3	38	50	13	0	3.25	.71
14.	5	50	38	0	13	3.25	1.04
15.	25	63	13	13	13	3.25	1.16
16.	13	38	25	25	0	3.14	.90
17.	27	38	38	0	13	3.14	1.07
18.	28	38	38	0	13	3.14	1.07
19.	26	38	25	13	13	3.00	1.15
20.	29	50	13	25	13	3.00	1.20
21.	24	50	13	13	25	2.88	1.36
22.	30	50	13	13	25	2.88	1.36
23.	18	25	38	13	13	2.86	1.07
24.	21	38	25	10	25	2.86	1.35
25.	14	25	25	13	13	2.83	1.17
26.	19	13	50	13	13	2.71	.95
27.	4	13	50	13	25	2.50	1.07
28.	22	25	25	13	38	2.38	1.30
29.	23	38	13	13	25	2.38	1.60
30.	20	13	25	25	13	2.14	1.35

Standard deviation ranged from low of .00 to high of 1.60.

*% answering A, B, C, D. Effort was made not to tabulate "E" responses.

APPENDIX E

RANK ORDER OF QUESTIONNAIRE RESULTS, EMPLOYERS' RESPONSES

	Item	A*	B	C	D	Mean	S.D.
1.	9	76	16	8	0	3.68	.63
2.	1	80	4	8	0	3.63	.97
3.	7	76	8	16	0	3.60	.76
4.	29	60	32	4	0	3.58	.58
5.	30	64	20	4	4	3.42	1.06
6.	8	60	20	20	0	3.40	.82
7.	15	60	24	12	4	3.40	.87
8.	25	64	20	12	0	3.40	1.00
9.	5	44	40	12	4	3.24	.83
10.	10	60	20	12	8	3.32	.99
11.	26	44	32	12	8	3.17	.96
12.	13	32	40	28	0	3.04	.79
13.	2	48	12	24	12	3.00	1.14
14.	27	32	32	12	8	2.96	.91
15.	28	48	20	12	20	2.96	1.21
16.	3	32	28	40	0	2.92	.86
17.	12	36	24	28	8	2.92	1.02
18.	4	32	32	24	4	2.88	1.08
19.	11	32	28	28	8	2.88	.99
20.	16	28	32	32	8	2.80	.96
21.	6	28	32	24	4	2.75	1.11
22.	17	12	44	36	8	2.60	.82
23.	19	20	12	40	28	2.24	1.09
24.	18	8	16	28	40	2.00	1.22
25.	21	8	28	24	36	2.00	1.08

APPENDIX E (cont'd)

	Item	A*	B	C	D	Mean	S.D.
26.	24	8	16	28	40	1.83	1.05
27.	22	32	32	28	4	1.76	1.05
28.	23	4	24	24	40	1.76	1.05
29.	14	4	12	36	44	1.68	.90
30.	20	4	16	28	44	1.64	.99

Standard deviation ranged from low of .58 to high of 1.14.

*% answering A, B, C, D. Effort was made not to tabulate "E" responses.

APPENDIX F

RANK ORDER OF QUESTIONNAIRE RESULTS, GRADUATE RESPONSES

	Item	A*	B	C	D	Mean	S.D.
1.	1	77	17	0	3	3.60	.93
2.	7	77	10	3	3	3.59	.98
3.	28	60	17	13	0	3.52	.75
4.	27	57	30	10	0	3.48	.69
5.	15	67	17	10	7	3.43	.94
6.	25	60	23	17	0	3.43	.77
7.	26	50	37	10	0	3.41	.68
8.	30	57	23	3	10	3.36	.99
9.	8	53	23	20	0	3.34	.81
10.	9	50	30	17	0	3.34	.77
11.	29	53	27	7	10	3.28	1.00
12.	10	50	20	20	3	3.25	.93
13.	5	43	33	17	3	3.21	.86
14.	2	47	13	27	3	3.15	.99
15.	16	40	33	20	3	3.14	.88
16.	11	43	20	17	13	3.00	1.12
17.	13	43	20	23	7	2.97	1.15
18.	3	37	17	37	3	2.93	.98
19.	12	33	27	33	0	2.90	1.01
20.	6	33	23	23	17	2.76	1.12
21.	17	33	20	33	10	2.70	1.15
22.	24	30	27	27	10	2.63	1.22
23.	18	23	20	33	13	2.59	1.05
24.	19	27	17	40	13	2.59	1.05
25.	21	27	20	30	20	2.55	1.12
26.	22	13	40	20	23	2.45	1.02
27.	4	27	13	33	17	2.38	1.27
28.	20	17	17	33	27	2.25	1.08
29.	14	10	23	37	30	2.13	.97
30.	23	17	20	27	30	2.10	1.21

Standard deviation ranged from low of .69 to high of 1.27.

*% answering A, B, C, or D. Effort was made not to tabulate "E" responses.