Table 3. Comparison of the different methods for the determination of natural radiocarbon (*6*).

	Solid carbon screen-wall counter (*2*)	Liquid paraffin 100 ml scintil-lation counter (*6*)	Gas counting 1 lit acetylene (*7*)
Sample size (wt. of carbon)	8 g	47 g	1 g
Counting efficiency (percent)	5.4	25	75
Net background (counts/min)	4	26	2.34
Net counts/min from modern carbon	6.7	182	10.72
Statistical error for modern carbon in years after 2 days of counting	±120	±17	±50
Maximum age limit in years (4 σ) 2 days of counting	25,000	44,000	38,000

preparation requires less than 12 man-hours of labor; and (iii) the remarkable stability of the counting system and the reproducibility of the absolute counting rates eliminate the need for more than one check run every 2 to 3 wk.

Thanks are due to W. F. Libby for much helpful advice in general matters of C^{14} counting, and to N. Sugarman for valuable discussions on proportional counting.

References and Notes

1. Publication authorized by the director, U.S. Geological Survey.
2. W. F. Libby, *Radiocarbon Dating* (University of Chicago Press, Chicago, 1952).
3. W. R. Champion, U.S. Geological Survey, has kindly carried out radium determinations of commercial $SrCl_2$ and $BaCl_2$ and found the $BaCl_2$ usually about 100 times higher in Ra than the $SrCl_2$, which contains about 10^{-14} g Ra per gram $SrCl_2$.
4. H. E. Suess, paper presented at the NSF conference, Oct. 1953, Williams Bay, Wis.
5. Harmon Craig, *Geochim. et Cosmochim. Acta* **3**, 53 (1953).
6. See also J. R. Arnold, *Science* **113**, 155 (1954).
7. While this work was in progress. A. R. Crathorn [*Nature* **172**, 632 (1953)] attempted the use of acetylene as a counter gas for C^{14} determinations. For unknown reasons, however, a background of 30 counts/min was obtained with a 3-lit counter. This makes the use of his particular system impractical.

Metallo-Flavoproteins and Electron Transport

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ALTHOUGH the importance of metals in biological oxidations has been generally recognized (*1, 2*), there have been, until very recently, relatively few documented instances of the presence of metals in those oxidizing enzymes that have been isolated and characterized. Copper has been found to be the functional group of monophenol oxidase (tyrosinase) (*3*), polyphenol oxidase (laccase) (*4*), and ascorbic oxidase (*5*), while iron in the form of its porphyrin complex has been established as the functional group of catalase (*6*), peroxidase (*7*), yeast lactic dehydrogenase (*8*), and the cytochromes (*1, 9, 10*). This article summarizes some recent developments that provide additional confirmation of the pivotal role of metals in electron transport.

Metallo-flavoproteins are a group of enzymes containing both metal and flavin in firm linkage with the protein and in definite proportions. Thus far, seven enzymes have been characterized as metallo-flavoproteins, and three metals—copper, iron, and molybdenum —have been implicated as the functional metal. For simplicity of presentation, it may be desirable first to describe the general catalytic properties of each of these flavoprotein enzymes before considering the special function of the metal in the electron-transport sequence.

Acyl CoA dehydrogenases. Animal tissues contain two enzymes that catalyze the reversible oxidation of fatty acyl CoA's to their corresponding trans α,β-unsaturated derivatives (*11, 12*). Both have now been isolated from beef liver mitochondria in essentially homogenous state. One, which we shall refer to in this article as the *green enzyme,* is specific for the short-chain acyl CoA's from C_3 to C_8, while the other, which we shall refer to as the *yellow enzyme,* is active on all acyl CoA's from C_4 to C_{18}. Both enzymes contain flavinadenine dinucleotide as prosthetic flavin but differ in the nature of the prosthetic metal. The green enzyme contains copper (2 atoms per molecule of flavin), while the yellow enzyme may contain iron.

The absorption spectrum of the green enzyme shows the characteristic flavin bands at 355 and 432 mμ and, in addition, a new band at 680 mμ which is referable to copper or its appropriate complex. The deep green color of the enzyme stems from this band in the red end of the spectrum. When the enzyme is reduced by its substrate, both the flavin and copper bands disappear, and they reappear when the reduced enzyme is oxidized by molecular oxygen or other oxidizing agents. The absorption spectrum of the enzyme after removal of copper by mild procedures closely resembles that of a typical flavoprotein—that is, a flavo-

protein uncomplicated by the presence of functional groups other than flavin.

The yellow enzyme shows a typical flavoprotein spectrum in the oxidized state, but the spectrum of the reduced form is anomalous. A new broad band at 525 to 580 mμ appears on reduction of the enzyme. Whether the metal is implicated in this spectral change is as yet undecided.

The oxidation-reduction potential of the substrate system, acyl CoA-unsaturated acyl CoA, is about +0.25 v at *p*H 7.0 and 25°C. Because of this relatively positive potential, few of the conventional electron acceptors like methylene blue can be used for assay of the enzyme. Ferricyanide, some of the indophenols and quinones, and cytochrome *c* serve as satisfactory acceptors, but oxygen is far too sluggish.

Xanthine oxidase. This flavoprotein enzyme, which has been isolated from cow's milk in highly purified form, catalyzes the oxidation of hypoxanthine (and several related purines), aldehydes, DPNH (dihydrodiphosphopyridinenucleotide) and pterins (*13–17*). The lack of any obvious chemical resemblance between, for example, DPNH on the one hand and aldehydes and hypoxanthine on the other or between aldehydes and hypoxanthine has engendered considerable skepticism whether the same flavoprotein enzyme is responsible for all these oxidations (*16, 18*). Recent studies in our laboratory have confirmed the conclusion reached 15 yr ago that all these activities are associated with the same protein and that the same functional groups of the enzyme participate in each of the four oxidative reactions (*19*). Traditional concepts of sharp enzyme specificity admittedly are dealt a severe blow by these unusual properties of milk xanthine oxidase. No doubt it will tax ingenuity to provide a satisfactory explanation for this broad range of activities.

Westerfeld *et al.* (*20*) and De Renzo *et al.* (*21*) discovered that intestinal xanthine oxidase was relatively low in rats maintained on a molybdenum-deficient diet and that the level could be restored to normal by addition of minute amounts of molybdenum to the basal diet. These observations stimulated the search for molybdenum in xanthine oxidase. Several investigators have now confirmed the presence of molybdenum in xanthine oxidase—the molybdenum to flavin ratio being 1:2 (*22, 23, 24*) in the isolated purified enzyme. Since detachment of the metal from the protein can be shown to occur throughout the purification procedure used, this ratio in the native enzyme may be 1:1 or even greater. Similar considerations also obtain for the aldehyde oxidase described in later paragraphs.

Concentrated solutions of milk xanthine oxidase are brownish red in color, whereas typical flavoproteins are lemon yellow. Indeed, assay of the enzyme for flavin as flavinadenine dinucleotide discloses that flavin can account for no more than 40 percent of the total absorption at 450 mμ. The residual absorption at 450 mμ is referable to a second chromophoric substance in the enzyme molecule that is as yet unidentified (*15, 19, 25*). This substance, which is metal free and cannot readily be split off from the protein, shows a band at 415 mμ and absorbs generally throughout the rest of the visible spectrum. Molybdenum makes no contribution to the spectrum since the spectrum of the molybdenum-free enzyme is indistinguishable from that of the original enzyme.

One of the most perplexing features of xanthine oxidase has been the observation, first made in 1938, that the prosthetic flavin is not reduced rapidly enough to accommodate the hypothesis that flavin is reduced and oxidized during the catalytic cycle of the enzyme (*15*). This dilemma has finally been resolved. Morell has shown (*18*) that on addition of hypoxanthine or aldehyde a fraction of the flavin (less than 60 percent) is rapidly reduced, whereas the remaining oxidized flavin is only slowly reduced. In our laboratory evidence has been obtained (*19*) that the partial reduction of flavin is a consequence of an equilibrium between two oxidation-reduction systems—that of the substrate and that of the enzyme. The potential of the couple, reduced enzyme-oxidized enzyme, (E_0' of −0.45 v at *p*H 7.0 and 38°C) is more negative than that of the couples, hypoxanthine-xanthine (E_0', −0.37 v), xanthine-uric acid (E_0', −0.36 v), and DPNH-DPN^+ (E_0', −0.32 v). The couple of the system, aldehyde-acid, has not been measured but is estimated to be below −0.4 v. The slow reduction of all the enzyme-bound flavin which follows the initial quick reduction is probably an irreversible process that has no bearing on the normal state of the enzyme. Either loss of metal from the reduced enzyme or reduction of the metal to a lower valency state than is normally involved could explain this slow "overreduction."

The oxidation-reduction potential of the xanthine oxidase enzyme couple, which is several hundred millivolts more negative than that of simple flavoproteins or flavinadenine dinucleotide, may reflect a contribution of molybdenum to the potential. Perhaps the enzyme couple consists of the components, Mo^V, $FADH_2$-Mo^{VI}, FAD.

The xanthine oxidase system is not only indiscriminate with respect to the types of substrates oxidized but shows equal lack of partiality to electron acceptors. Molecular oxygen, oxidation-reduction dyes, ferricyanide, cytochrome *c*, nitrate, and quinones are all equally effective. The enzyme also catalyzes the interaction of the reductant of one substrate with the oxidant of a second—for example, oxidation of hypoxanthine or aldehyde by DPN or oxidation of aldehyde by uric acid as shown by the equations:

$$\text{Hypoxanthine} + \text{uric acid} \rightleftharpoons 2\ \text{xanthine}, \quad (1)$$

$$2\ \text{aldehyde} + \text{uric acid} \rightarrow 2\ \text{acid} + \text{hypoxanthine}, \quad (2)$$

$$\text{Hypoxanthine} + 2\ DPN^+ \rightleftharpoons \text{uric acid} + 2\ \text{DPNH}, \quad (3)$$

$$\text{Aldehyde} + DPN^+ \rightarrow \text{acid} + \text{DPNH}. \quad (4)$$

Liver aldehyde oxidase. A flavoprotein has been isolated from pig liver that catalyzes the oxidation specifically of aldehydes by the same group of acceptors as are effective with xanthine oxidase (*26*). Three pros-

thetic groups have been found to be present in the enzyme at the highest purity level (> 90 percent), namely, flavinadenine dinucleotide, molybdenum, and iron-protoporphyrin in the ratio of 2:1:1 (*27*). As a result of repeated precipitations of the purified enzyme, both metal and hemin can be progressively detached from the enzyme, and thus in the limit only flavin remains attached to the protein.

The absorption spectrum of the enzyme is compounded of contributions from both hemin and flavin. The effect of the high Soret band of hemin is to blur the characteristic flavin bands at 360 and 450 mμ. Unlike the flavin of the xanthine oxidase, the flavin moiety of aldehyde oxidase is completely reduced in the rapid phase. The hemin moiety may be the determinant of the relatively positive potential of the enzyme couple. The aldehyde oxidase enzyme couple may consist of the components: Mo^{V}, $FADH_2$, Fe^{++} (hemin)-Mo^{VI}, FAD, Fe^{+++} (hemin). Hemin by virtue of its relatively positive potential would thus have the effect of shifting the equilibrium in favor of complete reduction of flavin by aldehyde.

DPNH-nitrate reductase. Nason *et al.* have isolated from Neurospora a flavoprotein enzyme that catalyzes the oxidation of TPNH by nitrate (*28*). A molybdenum requirement emerges with purification of the enzyme. Whether nitrate is the only electron acceptor for this flavoprotein still has to be determined. In this connection it is of interest to point out that xanthine oxidase can also qualify as DPNH-nitrate reductase by virtue of catalyzing the oxidation of DPNH by nitrate. The reduction of nitrate may well be a peculiarity of molybdo-flavoproteins.

Hydrogenase. Many bacteria contain an enzyme that catalyzes the reversible oxidation of molecular hydrogen by oxygen, dyes, cytochrome *c*, and nitrate (*29–31*). The resemblance of the electron-acceptor pattern of hydrogenase to that of xanthine and aldehyde oxidases suggested to us the possibility of hydrogenase being a molybdo-flavoprotein. Some recent studies of Wilson *et al.* (*32*) appear to confirm this prediction. An unequivocal requirement for molybdenum has been shown for the reaction of hydrogen with cytochrome *c*. Purified preparations of the enzyme from *Clostridium pasteurianum* have the brownish-red appearance similar to that of milk xanthine oxidase.

DPNH cytochrome reductase. Two flavoprotein enzymes, both of which have been isolated from pig heart muscle, are concerned in the oxidation of DPNH. One (diaphorase) catalyzes the oxidation by dyes such as indophenols (*33–35*), while the other (DPNH cytochrome *c* reductase) reacts with cytochrome *c* as well as with dyes (*36, 37*). Apart from this difference, as far as electron acceptor is concerned, there are other differences which appeared to eliminate the possibility that diaphorase is a derivative of DPNH cytochrome *c* reductase. The former is a fluorescent flavoprotein containing FAD as prosthetic group, while the latter is a nonfluorescent flavoprotein whose flavin prosthetic group is a dinucleotide not identical with FAD. Furthermore, diaphorase contains no metal, whereas the reductase contains 4 atoms of iron per molecule of flavin (*38*).

The question of the possible identity of these two flavoproteins was reopened with the discovery that after removal of iron from DPNH cytochrome *c* reductase, the capacity to react with cytochrome *c* was lost and the metal-free derivative enzyme was thus functionally indistinguishable from diaphorase, although a difference still existed with respect to fluorescence and the nature of the flavin prosthetic group (*39*). The possibility has to be entertained that DPNH cytochrome *c* reductase under one set of conditions can be converted to classical diaphorase and under another set of conditions to the nonfluorescent diaphorase that arises following removal of iron from reductase.

Coincident with reduction of the flavin of DPNH cytochrome *c* reductase, the metal atoms are converted to their ferrous forms, while during oxidation of reduced flavin the metal atoms are converted to their ferric forms. There is no evidence of the presence of iron-porphyrin in DPN cytochrome *c* reductase. The iron atoms, therefore, are in a form for which there is no precedent among oxidation enzymes apart from the case of acyl CoA dehydrogenase and of tryptophan peroxidase, which has recently been shown (W. E. Knox, personal communication) to contain iron in a nonhematin form.

The absorption spectrum of the enzyme in the oxidized state does not depart significantly from that of typical flavoproteins. There is evidence of a band at 525 to 600 mμ in the reduced form which is similar to that shown by the reduced acyl CoA dehydrogenase (yellow enzyme).

Interaction of metal and protein. Considerable differences exist among metallo-flavoproteins with respect to the ease with which the prosthetic metal can be reversibly detached. Copper is not dissociable from the green enzyme either during the purification procedure or on storage of the enzyme for long periods of time. Only by prolonged dialysis against cyanide is it possible to remove copper from the enzyme. On the other hand, molybdo-flavoproteins readily part with their metal even under relatively mild conditions, such as dialysis against dilute ammonia or repeated precipitations with ammonium sulfate. Iron as in DPNH cytochrome *c* reductase is intermediate between copper and molybdenum as far as ease of detachment from the protein is concerned.

The apoenzymes show very sharp specificity for the metal. Thus iron cannot reactivate the copper-free acyl CoA dehydrogenase, nor can copper reactivate the iron-free DPNH cytochrome reductase. Similarly, neither iron nor copper nor any of a long list of other metals can substitute for molybdenum in reactivating metal-free xanthine or aldehyde oxidase, with the exceptions noted in the following paragraphs.

Certain metals closely related to molybdenum in their electronic structure and in their chemical reactivity can replace it, however, to a certain extent. Thus tungstate can replace molybdic oxide at about 50-per-

cent efficiency in the case of aldehyde oxidase, while uranyl ions can substitute for molybdenum to the extent of 10 percent in the case of xanthine oxidase. But the situation cannot be reversed: uranyl is inactive for aldehyde oxidase, while tungstate cannot replace molybdenum in the case of xanthine oxidase. This high degree of specificity with respect to the metal utilized is unique, both in the field of metal complexes and in that of other metal-activated enzymes. The protein must therefore exert a considerable selectivity in the binding, and the binding site must show a highly oriented steric configuration.

The number of molecules of metal necessary for full reactivation of 1 molecule of apoenzyme is far higher (up to 5000 times) than the molecular ratio of the two in the unresolved enzyme. This discrepancy between the concentration in the enzyme and the concentration to which the apoenzyme has to be exposed for maximal reactivation is not an unfamiliar one in studies of conjugated enzymes. Enzymes that have lost their prosthetic metal may not bind metal again by the same linkages as were involved in the original enzyme. In other words, the metal is no longer held in the same firm linkage as in the unmodified enzyme. Molybdenum poses a special difficulty with respect to the form in which the metal can be presented to the apoenzyme. Molybdenum does not exist as the simple metal ion in solution. In the form of molybdate it may be a far cry from the correct state of the active metal. In point of fact, molybdic trioxide is active under conditions where molybdate is completely inactive.

Function of the metal. The study of the seven metallo-flavoproteins described in foregoing paragraphs has revealed a very consistent pattern for the role of metal to which no exception has yet been found. The metal plays no role in the interaction of the reduced enzyme with organic oxidation-reduction dyes, quinones, and molecular oxygen. These reactions go on equally well whether the metal is present in or removed from the enzyme. It should be noted that all these oxidizing agents require 2 electrons for a reductive step. However, metal is required absolutely for the interaction of reduced enzymes with 1-electron acceptors such as cytochrome *c* and ferricyanide. Nitrate is the one apparent exception to this rule. However, since there is no knowledge of the steps involved in the enzymatic conversion of nitrate to nitrite and since N^{IV}(as in NO_2) is certainly a possible valency state for the first intermediate in the conversion, there is at present no basis for deciding how serious an exception nitrate is to the rule that metal plays a role exclusively in the interaction of reduced flavin with 1-electron acceptors. It should be added that nitrate reduction is a phenomenon confined to the molybdoflavoproteins—a fact that suggests complexing between metal and nitrate.

The foregoing facts call to mind Shaffer's equivalence theory (*40*), which is based on observations that are variations of the following case. A reductant involving a valency change of 2 electrons reacts slowly, if at all, with an oxidant involving a valency change of 3 electrons. The interaction can be catalyzed by a mediator involving a 1-electron valency change. The mediator facilitates the stepwise removal of electrons from reductant to oxidant and overcomes the energy barrier imposed by the necessity for simultaneous collision of multiple molecules of reductant and oxidant. The Shaffer theory is not strictly applicable to the metallo-flavoproteins, since both the metal mediator and the oxidant undergo the same valency change, namely, 1 electron. However, the Shaffer theory does point up a difficulty of mechanism inherent in the transfer of electrons from a member of one valency group of oxidation-reduction system to a member of another valency group. The function of the metal may be to complex simultaneously with 1 molecule of flavin and 2 molecules of acceptor. In this sense, the metal would be facilitating a ternary collision.

There is another aspect of the problem that may warrant consideration. The reactions between reduced flavoproteins and their respective electron acceptors have been, heretofore, regarded as one-step oxido-reductions. The implication of metal ions in this process has in effect introduced additional steps. There is some evidence that the 4 iron atoms in DPNH-cytochrome reductase are not equivalent but belong to two different groups. The electron flow may be represented by the following sequence, where arrows indicate the directions of electron flow:

Substrate → flavin → metals of group I → metals of group II → acceptor.

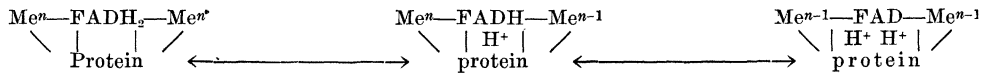
Since, in the presence of appropriate enzymes, this sequence is capable of being tapped, at least in theory, at each intermediate step, additional parameters have been introduced into a process which by virtue of its stark simplicity appeared forbidding of ever yielding to a study of mechanism.

Little has been said so far about the structural aspects of metallo-flavoproteins. The metal forms coordination covalencies not only with the flavin nucleotide but also with the protein. At least in the case of cytochrome reductase, the inference is strong that two of the valencies of the iron atom are able to chelate with cytochrome *c*. It is tempting to generalize from this observation and to postulate that metals capable of linking two or more catalytically active proteins by chelation play a role not only in the initial but also in the ultimate stages of electron transport.

Albert's observations on the complexing of metal ions by riboflavin (*41*) have been the starting point for some further studies in our laboratory which bear on the structural features of chelation. We have found that the flavin nucleotide coenzymes are even more effective complexing agents for iron than riboflavin proper. When a flavin nucleotide and ferrous ammonium sulfate are incubated with the iron-binding globulin of human plasma, an artificial "ferro-flavoprotein" is formed (*39*). A complex of this sort shares many of the properties of the enzymatically active metallo-flavoproteins, such as absorption spectrum. Removal of the iron, however, invariably leads to com-

plete dissociation of the complex. This is not the case with the metallo-flavoprotein enzymes. There it is frequently possible to split out the metal and leave the flavin still bound to the protein. From this we have concluded that, although the protein-metal-flavin link is indubitably of importance, flavin must be linked to the protein by additional bonds as well.

The interaction of reduced molybdo-flavoproteins



with 1-electron acceptors such as cytochrome *c* or ferricyanide does not proceed in the absence of added inorganic phosphate. Arsenate replaces phosphate to a small degree. The full meaning of this phosphate requirement has yet to be clarified, but the possibility that phosphate esterification accompanies valency changes in the metal is not unlikely. The intervention of a metal in the electron-transport sequence may thus provide a mechanism for phosphate esterification.

In this connection it may be of significance that other ions that are capable of forming strong complexes with Mo^{V}, such as silicate, can replace phosphate, while others that are isosteric with it but incapable of interaction with the metal, such as sulfate or perchlorate, are ineffective.

The recent study of Wosilait *et al.* (*42*), as well as the classical investigations of Wieland (*43*) and Booth (*44*), has directed attention to the useful features of quinones as electron acceptors particularly for flavoprotein enzymes. The oxidation-reduction potentials of a large number of quinones have been determined and several series of compounds of related chemical structure, covering a wide range of potential, are readily available. It has been shown recently that quinones can be used as electron acceptors for a wide variety of flavoproteins (*45*). In general the velocity of interaction of any one enzyme with a series of quinones increases as the potential of the quinone becomes more positive, until maximum velocity is attained above a critical potential value. The effect of the metal on this relationship is both pronounced and consistent. The potential plateau is changed by about ± 50 mv when metal is present compared with the situation when metal is removed from the enzyme. Furthermore, the slope of the log velocity-potential plot is much steeper in the absence of metal. From these facts, we have concluded that metal plays a determinant role in the potential of the flavoprotein enzyme system and that the metal profoundly influences the reaction characteristics of the flavin with which it is associated.

A metallo-flavoprotein should, therefore, be regarded as an entity and not simply as a loose aggregate or complex of the three components—metal, flavin, and protein. Thus at all times, in the native enzyme, the metallo-flavin, together with the amino acids surrounding the site of its attachment to the protein, forms part of the same resonating system. The mobile π-electrons of this unit are distributed over a considerable volume. For this reason 1-electron intermediates (the semiquinones of Michaelis) arising during catalysis may have considerable stability even at physiological *p*H values and may prove to be of importance mechanistically. An alternative formulation might be to regard the reduced form of a flavoprotein, as written ordinarily, as only one of several possible resonance forms, some of which may carry the semiquinone structure implicit in their structure, for example,

During active catalysis, a further enlargement of the resonating system takes place to include π-electrons not only of the metallo-flavoproteins but also those associated with the substrate and/or electron acceptor. In this manner, the transfer of electrons from one part of this essentially intramolecular system (the substrate) to another (the acceptor) is facilitated considerably.

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Attitudes of College Seniors toward Federal and Industrial Employment

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ATTITUDES of graduating seniors in engineering, science, and social science were assessed in the spring of 1952 by The American University (*1*). The purpose was to study the reasons why graduates did or did not take Federal employment (*2*). The research grew out of a pilot investigation by George P. Bush which indicated the need for further investigation of student attitudes and extension of the study to additional major fields (*3*).

We administered a questionnaire to seniors, faculty and placement officers in field visits to five colleges and universities (*4*). The questionnaire was supplemented with interviews, primarily with faculty and placement officers, for background information and opinions. Final assessment of student attitudes was based solely on responses to the questionnaire. For this reason, its development should be discussed briefly.

The Questionnaire

The questionnaire was designed to accomplish objectives established by the University committee directing the research. These objectives were

1) To measure the students' degree of preference for Federal employment as compared with industrial employment

2) To discover the extent to which students' attitudes concerning the advantages and disadvantages of Federal and industrial employment (derived from interview and questionnaire comment in the pilot study) influence student job decisions

3) To discover (i) the sources of information concerning employment which influence the student as he makes his job decision and (ii) the relative values that he assigns to these sources

4) To discover (i) the attitudes of faculty members toward the factors of employment influencing students, (ii) faculty members' sources of information, and (iii) the relative values they assign to these sources

5) To compare (i) student and faculty attitudes and sources of information and (ii) attitudes of engineering students with those of science and social science students

6) To determine the time when college seniors make their final decision to accept or reject specific employment opportunities

The questionnaire included questions to provide information concerning student behavior in the recruitment process, such as the time of job decision, amount of salary received, and sources of information about employment opportunities. For the analysis of attitudes 38 statements concerning industrial and Federal employment were presented in the form of a Likert-type scoring schedule. The student was asked to indicate his agreement or disagreement with the statement. Five degrees of agreement or disagreement were provided.

The 38 items were based on statements that students themselves had used in the pilot study. Several statements were included in each of the following areas: benefits, pay, promotion, job security, recruitment, professional development, and working conditions. Examples of the statements are

> Experience gained in Federal employment becomes a poor recommendation for future work in industry.
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> Opportunities for additional training in my professional field are greater while working in private industry than in government.
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> A person working for the Federal Government in my field has a greater job security than in private industry.
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> In my field, individual initiative on the job is given higher recognition in government than in similar industrial work.