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JOB MOBILITY OF ACADEMIC PHYSICISTS IN AMERICAN HIGHER EDUCATION: A PRELIMINARY STUDY

by

Arvel Lawrence Fincher

A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy in
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1969

Doctoral Committee:

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JOB MOBILITY OF ACADEMIC PHYSICISTS IN AMERICAN HIGHER EDUCATION: A PRELIMINARY STUDY

by

Arvel Lawrence Fincher

Chairman: Norman C. Harris

This work is a preliminary study of the job mobility of academic physicists in American higher education institutions that offer a physics major to the baccalaureate level. The study has been set in a theory framework of interacting social systems with an emphasis on the family, educational, and work social systems. Job mobility has been assessed in terms of a change in primary work activity or job title as well as a change of employer.

Survey sampling methods employing a mailed questionnaire have been used to collect data, and standard statistical techniques have been used in analyzing results. A random sample of 800 academic physicists stratified according to academic rank was drawn from the Directory of Physics & Astronomy Faculties 1967-1968, a publication of the American Institute of Physics. Survey results have been analyzed in terms of means, standard deviations, correlation coefficients, chi-square, Cramer's statistic, and an index of predictive association.

Questionnaires were returned by fifty-nine percent of the persons in the sample. Examination of the returns in terms of age, academic rank, and classification by employing institution level of degree offering revealed minimal non-response bias.

The central finding of the study was that academic physicists have had an average of 3.5 jobs and 2.6 employers during their career. Relationships between mobility and social system variables showed the work system to be clearly the most significant context of influences on mobility. Congeniality of colleagues and competency of colleagues were identified as the most important factors in job choices, and economic factors were identified as the least important. Statistically significant relationships were found for mobility and age, academic rank, teaching activity, administrative activity, tenure, and publications productivity. Statistical measures of strength of association between mobility and social system variables and of predictability of mobility from data on system variables did not give strong or highly predictable findings. Survey results showed that sixty percent of the academic physicists had been employed only in academic institutions.

Of seven hypotheses tested, four have been found to be acceptable at an 0.05 level of confidence: (1) mobility decreases with age, (2) mobility decreases after a tenured position is attained, (3) the prestige of the institution where an individual receives his degree correlates with the prestige of his employing institution even when the effects of his productivity are considered, and (4) the dominant pattern of interprestige mobility is downward in the prestige hierarchy (even after the expected downward move from degree granting to first employer institution is excluded). Rejected hypotheses were that mobility increases with higher education degree attainment, that mobility decreases with increasing family responsibility, and that high publication productivity correlates with stable or upwardly directed interprestige mobility.

PREFACE

This dissertation has been written as a preliminary study limited to the examination of the job mobility of academic physicists in American higher education. The theory framework has considered individual physicists in an interactional setting provided by the social systems of the family, the educational system, and the work system. This social systems theory approach has been used in an attempt to identify relations between system influences and individual variables and to establish normative patterns of job mobility. The scope of the research is limited to a single sampling of the population of academic physicists for the academic year 1967-68. It is hoped that the findings of this work will be of value to physicists and higher education administrators who effect transactions in the academic marketplace.

Acknowledgement must be made for the invaluable assistance given by all members of the doctoral committee as the dissertation has progressed from the prospectus to the final copy stages. Special appreciation must be expressed to Professor Norman Haris, the doctoral committee chairman, for an extra measure of time contributed to the reading and critique of rough drafts. Economic assistance has been provided in a major way by a working wife, Marian Fincher, and in a minor way by the Veterans Administration through the "GI Bill".

Documentation has been made with a dual note system "to separate substantive notes from those largely devoted to citing sources" (University of Chicago Press 1969, p. 342). Citation notes will follow the

author-date method which calls for a parenthetical insertion as illustrated in the previous sentence. Substantive notes which consist of supplementary comment or explanation will be indicated by asterisks and will be placed at the bottom of the page containing the text they supplement.*

The writing has been organized broadly into two parts: first, an introductory section which sets forth the nature and background of the research problem and presents a conceptualization of academic physicists' mobility; and secondly, a description of the research including design, findings, analysis and summary.

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*These notes will usually not exceed one per page, and they are positioned for the convenience of the reader.

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PART I. INTRODUCTION

CHAPTER I

THE PROBLEM

Rationale for Choosing the Problem

The rationale for choosing the problem researched in this study may be outlined with a personal chronology of selected events and experiences which have influenced the choice (see figure 1). The roots of the problem identification go to experiences as a student and teacher of the discipline of physics and as a participant and student in higher education administration. Specific focus for the problem has been brought about by coursework on higher education manpower and its associated reading (particularly the two studies listed in the chronology). The culmination of these interests was a literature search which demonstrated the feasibility of researching a problem on the topic of the job mobility of academic physicists in American higher education institutions that offer a physics major to the baccalaureate level. The particular emphasis on job mobility has been chosen because of its relevance to higher education administration and its centrality as a characteristic of the work world of academic physicists. A complete discussion of the delimitations of the problem and its background may be found in the remaining sections of this chapter.

Physics and Society--A Brief Overview

Broad elements in the background of the problem of the job mobility of academic physicists may be sketched by considering the develop-

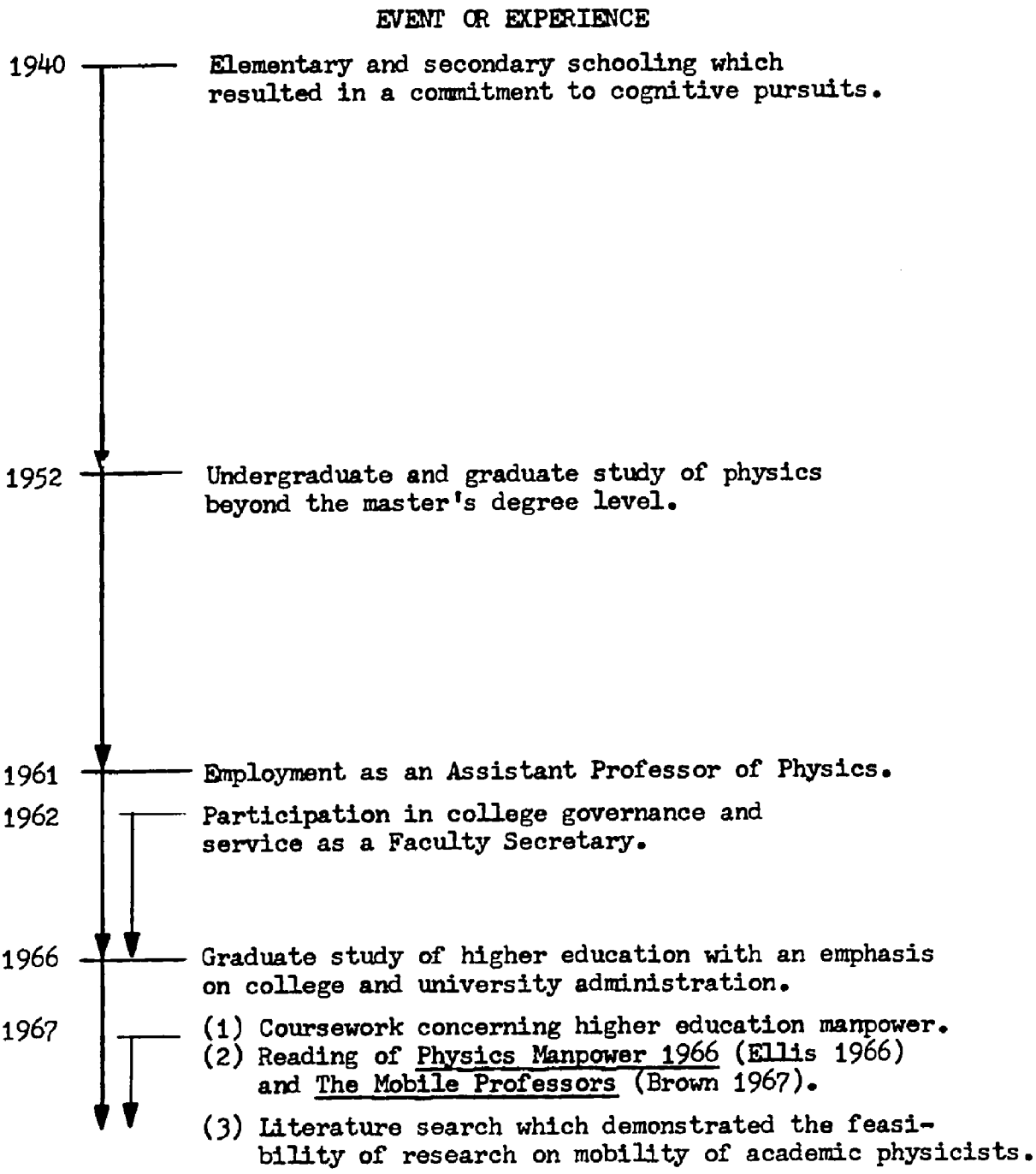


Fig. 1--Personal Chronology

ment of the significance of physics to society.

Earliest records of man show that he wondered about his physical environment. Considering the likely harsh realities of nature which fell upon him, it is not surprising that early religions included worship of "the sun, the moon, storms, and the sky" (Bradley 1963, p.8). Considering wonder about the physical universe as rudimentary physics, one may identify it as a major aspect of primitive religions which, in turn, were significant in the development of earliest society. Today, in highly civilized societies, men still wonder, and for some physics has become their religion.

In the time of the Greeks, natural philosophy evolved and brought forth some organized wondering (theories)--Aristotle and Archimedes on mechanics, Ptolemy and Euclid on light, Thales of Miletus on electricity and magnetism, and Democritus of Abdera on the atomic composition of matter (Cajori 1929, passim). These subjects of classical physics theory can be traced historically from the Greeks to the present time where one finds physicists still wondering about them. Although physics in the guise of natural philosophy had only limited significance in the practical matters of the Greek era, it did constitute a major element of the intellectual realm.

Physics did not become a greatly significant force in shaping Western society until the sixteenth century when it incorporated inductive methods of inquiry, an emphasis on the necessity of observation and experimentation in research. The contributions of Galileo and Newton during this time laid the foundations on which other scientists built a storehouse of knowledge which was instrumental in the transformation of society from an agricultural to an industrial orientation. Since the

sixteenth century, physics as translated into practical devices--the machinery of commerce--has been a very significant part of the economic and social structure of society.

About 1900 when the era of modern physics was ushered in by contributions of Einstein in relativity and Plank in quantum theory, physics reached a new level of significance for society. In the era of modern physics, basic research has led to developments such as atomic and thermonuclear energy sources, transistors, lasers, computers, and other electronic devices which have become the warp and woof of a technological society. According to the point of view, these developments are significant in that they provide man with the most highly sophisticated society ever to exist or that they are dehumanizing and capable of subjugating or even destroying the whole society.

The significance of physics lies not only in its specific contributions but in its role as a keystone or catalyst for other areas of knowledge. In discussing the relation of physics to other sciences, Richard P. Feynman has expressed the viewpoint that "physics is the most fundamental and all-inclusive of the sciences, and has had a profound effect on all scientific development" (1963, p. 3:1). Physics concepts and applications may be found as well in the social sciences and arts. Social scientists, for example, describe social systems in terms of "entropy" and "feedback", concepts which derive from the physics subjects of thermodynamics and electronics.* The use of magnetic field suspensions to produce a "free-floating" sculptural work provides an illustration of

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*This manner of description may be found in The Social Psychology of Organizations (Katz and Kahn 1966).

physics in art. With admitted overgeneralization, one may say that physics has significance wherever man wonders--rationally contemplates in a context of emotional overlays about himself and his environment.

In 1964 the National Academy of Sciences appointed the Physics Survey Committee (PSC), nineteen distinguished physicists, and charged the committee "to survey the state of physics research and education in the United States, and to identify and report on the requirements for growth and productivity in this discipline in the years immediately ahead." The report of this study (PSC 1966) discussed the "present position of physics in the United States" in terms of subcommittee reports on the areas of: Astrophysics, Space Physics, Cosmic Rays, and Gravitational Physics; Atomic and Molecular Physics and Quantum Electronics; Elementary-Particle Physics; Nuclear Physics; Plasma Physics; Solid-State (and Condensed-Matter) Physics; Theoretical Physics; Classical Physics; and Applied Physics. This identification of areas gives an idea of the nature of physics research at the present time. In the preface of the report the view is expressed that:

> Physics has provided modern man with one of the master keys to understanding the natural world. The knowledge developed through physics research has rapidly increased, and it continues to grow at an accelerating rate. Physics provides insights, instrumentation, and techniques of central importance to chemistry, biology, and the other sciences with which it shares an increasing number of scientific frontiers. Physics underlies most of engineering and serves as a source from which much new technology springs. The nation's scientists trained in physics are today among its indispensable educators, pioneers in technology, innovators in industry, and contributors to military strength and the national welfare.

Bertram D. Thomas, the President of Battelle Memorial Institute, has placed the question of the significance of physics in a broader perspective by arguing that:

> But what is going on in the world today is not a new Industrial Revolution. It is the birth of a new civilization, bringing in its wake changes in every facet of our existence--changes in order of magnitude greater than any that affected factories and workers of the Industrial Revolution. What is happening today may, by over-simplification, be described as the sudden interaction of science and society. And the effects of this interaction transcend both science and society. (1965, p. 19)

These brief considerations of the relation of physics to society provide general background for the present study and point to the significance of research directed toward an understanding of the academic physics social subsystem.

Background of the Problem

In a recent issue of Manpower Comments a summary statement of a survey made by the American Institute of Physics (AIP) may be found which reads:

> The production of physics baccalaureates continued to decline in 1966-67; . . . Only 4,900 physics majors received bachelor's degrees in 1966-67---130 fewer than the year before. The estimates show two significant trends: the total number of physics bachelor's continued to decline for the third consecutive year; and the drop-out rate at the junior year increased for the second consecutive year--from 27% in 1965 to 29% in 1966 to 30% in 1967. (Vetter 1968a, p. 18)

One reason suggested for the junior and senior year drop-outs was described in the AIP study, Physics Manpower 1966,as "poor college physics teaching" (Ellis 1966, p. 36). Declining baccalaureate production, increasing drop-out rates, and indications of inadequacies in the teaching function combine to provide circumstantial evidence which is suggestive of a need to study the social subsystem of academic physicists to gain some understanding of the dynamics of this central part of the physics manpower system. Although academic physicists are not the only subsystem component of physics manpower which could be profitably studied, they do constitute the basic and most significant element of production.

A few years ago, the Committee on Physics Faculties in Colleges (COPFIC) studied a number of four-year colleges and reported:

> The four-year colleges in the United States are now beginning to face a problem which promises to grow rapidly in severity in the immediate future. The problem is the recruitment and retention of able faculty, . . . The problem is already especially acute in physics, . . . The so-called "prestige" colleges find recruiting . . . difficult . . . more typical colleges find it nearly impossible. (COPFIC 1965, p.2)

The committee measured the extent of this problem by questioning chairmen of physics departments of approximately 600 non-Ph.D.-granting institutions, which offered a physics major, about their current and future needs or problems. Sixty-two percent of the 146 chairmen who replied said that securing competent faculty members was a significant problem (COPFIC 1965, p.9).

A finding of a like nature was reported by the National Education Association (NEA) in April 1965 after they had surveyed colleges and universities with respect to expected faculty shortages. The NEA finding was expressed in two ways: (1) of 940 institutions identifying shortages, 406 indicated that physics was a subject "for which a sufficient supply of competent teachers is not in sight," and (2) for the years 1963-64 and 1964-65 physics ranked second among fields having budgeted teaching positions unfilled with 110 reported (NEA 1965, pp. 24-25). These supply and demand statistics point more strongly to a need for research on academic physics manpower.

From a somewhat broader perspective, the Manpower Administration of the U.S. Department of Labor (USDL) has reported in its semiannual publication, The Job Market for Engineers-Scientists-Technicians:

> Tremendous increases in the Nation's supply of scientific and technical manpower will be needed to maintain high levels of economic activity and technological advance, increasingly complex efforts in research and development, a strong national de-

> fense, and our space program. The supply of chemists, physicists, life scientists, and mathematicians will need to be doubled by 1975. (USDL 1968, p. 4)

This indication of an increasing demand coupled with the previously noted declining supply of physicists highlights the need for research with a purpose such as David G. Brown has given for his work, The Mobile Professors: "to increase our understanding of how and why workers move among jobs so that ultimately we may do a better job of allocating scarce manpower (1967, p. 3).

During the progress of this study uncertainties have been introduced into the physics manpower picture regarding the effect of Selective Service draft policies and a proposed six billion dollar cut in the National Budget. In reference to these matters, Betty Vetter, the editor of Manpower Comments, has noted:

> The educational community is deeply concerned as budgetary constraints wipe out any hope of increase and forecast some decrease in Federal grants for postdoctoral and graduate assistantships, research grants, equipment, and fellowships . . . There appears to be no disagreement that physics is likely to suffer a greater relative loss than any other field through the combination of support loss and the draft. (1968b, p. 14)

The effects of budget cuts and an accompanying uncertainty have been reflected in reports of the placement service of the American Institute of Physics during 1968. The number of registrants seeking jobs increased and the number of firms using the placement service decreased. The job-market for physicists has suddenly tightened, especially in the area of research jobs, but there is little evidence of significant unemployment (Strassenburg 1969, p. 17).

With this picture of the present situation and the previous description of the state of academic physics in recent years as a background, it appears that a study of the job mobility of academic physicists could contribute to an understanding of the movements and allocation of

this segment of higher education's supply of highly qualified manpower.

Indications of Needed Research on Job Mobility

The background sketched in the previous section suggests a need for research on physics manpower and identifies academic physicists as a subsystem likely to yield research findings which would contribute to an understanding of physics manpower problems. This section gives some indication of the more specific need for research on job mobility.

The report of the Physics Survey Committee, Physics: Survey and Outlook, contained findings in the summary chapter which concluded that:

> Certain problems are common in physics throughout the United States. . . There is a serious shortage of qualified physics teachers at all educational levels. It progresses in severity toward the earlier educational years. There is some problem in the universities; it is severe in the four-year liberal arts colleges, probably more so in the junior colleges; and it may have reached alarming proportions in the nation's high schools. (1966, p. 114)

One recommendation of the report, which has been interpreted as an indicator of needed research, called for "better utilization of available physicists" (p. 116). The interpretation that has been made assumes that evaluation of utilization can be made only if information is available on job mobility.

In an article about the educational programs of the American Institute of Physics, A. A. Strassenburg, the AIP Director of Education and Manpower, has commented on work patterns of physicists and observed that:

> None of this information, interesting though it is, enables us to make predictions. For that purpose, we must study trends over several years, . . .I do believe that we can and should identify new employment patterns as they develop, and study the implications they have for our educational programs. For example, the greatly increased mobility of scientists with regard both to geographical location and work activity will alter past patterns of employment. (1967, pp. 804-5)

Since this indicator and the immediately preceding one emanate from the physics discipline, they might be suspect as reflecting self-interest, bias, or a myopic view, but indicators can be found in other disciplines and from other points of view which prove this not to be the case.

An observation from the disciplinary viewpoint of sociology can be found in the introduction to On Education--Sociological Perspectives edited by Donald Hansen and Joel Gerstl:

> From the time of the Great Depression to the Sputnik fright, all but a few sociologists in the United States remained comparatively indifferent both to the problems of education and to education as a social institution. In the last decade interest has increased, but even today most sociologists evidence scant enthusiasm for the sociological study of education. (1967, p. vii)

This observation is borne out when one searches the sociology literature and discovers much research on social mobility or occupational mobility, but with very little of it specifically concerned with educational institutions. The essence of this indicator lies in its identification of needed research by the absence of a significant amount of sociological study on topics such as the mobility of higher education faculty members. This lack may not only reflect the attitude of sociologists but also the reluctance of natural scientists to be studied by social scientists.*

An indicator from the viewpoint of economics may be found in the publication, Policy Conference on Highly Qualified Manpower, which resulted from a meeting of the Organization for Economic Co-operation and Development (OECD) at Paris, France on 28 September 1966. One conference study group reported "a review of methods of research on problems of utilization led to agreement on the need for more adequate research,"

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*This aspect of reluctance has been discussed by Bernard Barber and Walter Hirsch in The Sociology of Science (1962, p. 3).

and they also said a "prime need" existed for more data regarding "factors which affect the growth rates and distribution of the stock of highly qualified personnel" (OECD 1966, p. 41). In the conference report's section of conclusions regarding necessary research, one paragraph, headed "The careers followed by individuals during their active life," contained the statement:

> In order to reveal the dynamic aspects of the relationship between the individual and his employment, studies might be carried out covering:
>
> --the actual evolution of careers of highly qualified personnel.
> --mobility both within employing organizations and in the economy as a whole. (pp. 46-48)

The present study of job mobility of academic physicists has been conceived as a fulfillment of this indicated need for research as it applies to the physics component of highly qualified manpower.

A discussion of the findings from the search of the literature, given in Chapter II, will augment the indications of this section and add detail to the reference matrix in which the study is set. The focus on job mobility, conceived simply as movement from one set of work responsibilities to another, seems appropriate to yield information about "better utilization," "employment patterns," and "dynamic aspects of the relationship between the individual and his employment"--the needs mentioned in the indicators discussed above. Data on the amount and type of mobility will also provide a significant indication of the "health" of academic physics. Good health can be thought of in terms of the economic view which calls for some mobility to allow adjustment for expansion and shrinkage or supply and demand in the economy, but which sees large amounts of mobility as disruptive, costly and detrimental.

Delimiting the Problem

With the research area identified, the background sketched in, and some indications of needed research discussed, the remaining task in this introductory chapter is the formulation of a specific problem statement. In delimiting the problem, consideration has been given to selection of a logical segment of the physics manpower problem, to previous research that provides a matrix of reference for the study, to limitation of the number of variables so as to have a manageable analysis, and to available resources.

Assuming an academic manpower problem has been demonstrated, a logical analysis of the gross elements (students, faculty, facilities, etc.) of the manpower production system would naturally focus on the faculty as the keystone element; this natural focus has placed the limitation of "academic physicists only" on the study. The criterion of "offering a physics major to the baccalaureate level" has been used since these institutions essentially constitute the production system for physicists, and the criterion of "American higher education institutions" has been used because comparable, consistent data are available for these institutions.

The literature reveals that studies have been made on subjects such as the numbers of academic physicists, their geographical mobility, their income, and their level of academic training.* It also reveals that work has been done by psychologists, sociologists and others, which places academic physicists in group classifications as physical scien-

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*A collection of such data on patterns of utilization and trends in salaries 1948-62 may be found in Studies in Scientific and Engineering Manpower by Melville S. Green (1963).

tists or scientists. Such research usually has resulted in generalizations about group classifications and does not give specific characterizations of physicists or the subset of academic physicists. The specific limitation drawn from consideration of previous research has been the selection of an interstitial topic which has a body of allied or supporting literature that provides a source of comparison and concept definition.

As one begins to list the variables which might affect the job mobility of academic physicists it soon becomes evident that the possibilities are so numerous that some arbitrary choices must be made so as to have a manageable analysis. Such choices have been guided by the theoretical framework of the study, a social systems theory approach, which is developed in Chapter III. Variables such as age, marital status, degrees earned, number of publications, and academic rank have been chosen to reflect the major influences of the family, education, and work social systems on the academic physicists' job mobility.

The resource limitations for the study have been the available funds for research and the libraries, computing facilities, and faculty of the University of Michigan. Within the extent of these resources, the problem has been delimited at a point along a spectrum of levels which correspond to varying total resources and completeness of representation. Several spectrum levels may be envisioned as follows. With unlimited resources the problem might be framed as a "real world" open system model which could be computer simulated, take into account all identifiable factors influencing physics manpower development, and result in a forecasting model which could be used by physicists, educators, businessmen, and government officials as a decision-making device in personnel

management.* At a second level framing of the problem, a more easily researched "target-setting" or "planning" model could be constructed as a closed-system which neglects some realistic factors but results in useful data of a more limited application.** The third level down in framing the problem would be a study of some limited aspect designed to produce statistics and a limited analysis which could be incorporated later into a more extensive model-based research program. This limited aspect, a preliminary study, seems to be the practicable choice within the context of available resources.

The Problem Statement

The foregoing considerations of the problem researched in this study may be summarized as follows:

> Originating from interests based in the author's educational and teaching experiences, a problem has been selected within the area of physics manpower. Documentation by citations from the literature has been made to demonstrate a need for research with a particular focus on the job mobility of academic physicists in American higher education institutions which

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*The common characteristics of an open-system are given by D. Katz and R. L. Kahn as: importation of energy; the through-put; the output; systems as cycles of events; negative entropy; information input, negative feedback, and a coding process; steady state and dynamic homeostasis; differentiation; and equifinality (1966, pp. 19-26).

**Harbison and Myers describe the "target-setting approach" in these terms: "The purpose of target-setting is not to make prediction of what will take place; nor is it to make projections . . . Its purpose is rather to influence the future course of development. A target indicates a direction for action" (1964, p. 204). Tinbergen and Bos have developed "planning" models in terms of systems of linear equations which they see as guides "to help solve some quantitative, long-term educational-planning problems" (1965, p. 95).

offer a physics major to the baccalaureate level. The focus on job mobility has been conceived as relevant to higher education administration, central as a characteristic in the work system of academic physicists, and likely to yield research results which will provide insights into the dynamics of the physics manpower system. The problem has been delimited from considerations of previous research, the nature of the problem area, and available resources. From a stance as a preliminary study, this work is expected to produce findings which will meet an indicated need for physics manpower data that may be used to effect a greater understanding of the job movements of academic physicists and to facilitate decision-making in the allocation of this scarce human resource.

CHAPTER II

SEARCH OF THE LITERATURE

The Search Domain

To bring the study into focus, delimit the problem, and identify a matrix of previous research for purposes of concept definition and comparison of findings, a search domain was established with the literature of physics and higher education as central elements. Since a number of concepts and research methods for the study are drawn from other fields such as economics, psychology, and sociology, appropriate segments of the literature of these fields were also included in the search domain. Findings of the literature search are discussed in the following sections.

Significant Findings on Mobility

A book which is cited in many other references is The Academic Marketplace by Theodore Caplow and Reece J. McGee (1958). This work by two sociologists discusses previous research on the academic profession and notes that:

> The methods of social research have been applied by university professors to every important American institution except their own. There is an entire literature on the family . . . on the business enterprise, much research on religious, governmental, military, eleemosynary, and political institutions, but virtually nothing about the university as a social institution. (p. 1)

Their discussion of previous research revealed that there had not been a significant amount of research done on faculty mobility by the late

nineteen-fifties. The sample for their study included "all professional vacancies-and-replacements which occurred in the liberal arts departments of nine major universities during the academic years 1954-55 and 1955-56," and resulted in data of 215 interviews with department chairmen and 162 interviews with peers of faculty members. Although this work has been a significant contribution, it is limited by the fact that it studied only nine major universities and concentrated on interview methods. Some hypotheses to be tested in the present study have been drawn from the findings of The Academic Marketplace.

Two studies which Caplow and McGee did not discuss, but which have some relevance to the study of the mobility of faculty in the sciences, were done in the early fifties. One of these, Occupational Mobility of Scientists, was done by the Bureau of Labor Statistics of the U. S. Department of Labor (1953) and sought "to explore as many different aspects of mobility as possible and to test a variety of analytical techniques." The sample for this study was 1,122 individuals having a Ph.D. in biology, chemistry, or physics and constituted about 5% of the science Ph.D.'s in 1948. The study collected data on the scientists' first, last, and two longest intermediate jobs and found that the scientists on the average had held 3.2 jobs and had had 2.9 employers (pp. 1-2). A finding on transfers between types of employers revealed that "educators were less likely to change their type of employer," but that in comparison with other occupations regarding geographic mobility "Ph.D. scientists are one of the most mobile segments of the population." The finding was that 3 out of 4 stayed with a campus employer compared to 2 out of 3 staying with an industrial employer and 1 out of 2 staying with a government employer (p. 4). The conclusions of the study stated:

> In summary, the study indicates that, despite the employment stability of Ph.D. scientists, they must be characterized as a relatively mobile group in certain aspects. By the time they reach middle age, a large proportion have had experience in at least three of the functions normally performed by scientists. Most of them--whether educators, government employees, or employees in private industry--have worked for at least one other type of employer. The majority have held positions in two or more states. Moreover, more than half have transferred at one time from one scientific specialty to another. (p. 5)

The other study, The Making of a Scientist, by Anne Roe (1953) was conducted from the viewpoint of clinical psychology and involved sixty eminent scientists. Although this study included only seventeen physicists, its in-depth approach using psychological research methodology contributed to the limited theory that is applicable to the job mobility of physicists. One observation made by Roe that may be a significant indicator of cause for mobility was that, "The physicists are often anxious and neither interested in people nor very good at relating to them in general" (p. 233). In summarizing she said:

> One thing seems clear. Scientists are people, not rational automatons. They differ from other people in terms of what they do, in the things that give them satisfaction, more than in terms of completely special capacities. There is nothing you can say about them as persons that you cannot also say about some people who are not scientists. And there is almost nothing you can say about a man in some particular field of science that you cannot also say about someone in another field of science. In spite of this, there are patterns, patterns in their life histories, patterns of intellectual abilities, patterns of personality structure, which are more characteristic of special kinds of scientists than of other scientists. (p. 230)

One finding of Roe's study has been published more recently in The Management of Scientists (1964). In an article in this volume, she notes that "shifts from one institution to another during their professional lives have been remarkably few for the physicists" (p. 59). The tabular presentation of evidence given to support this remark was as follows:

TABLE 1

NUMBER OF INSTITUTIONS AFTER PH.D., INCLUDING PRESENT POSITION

Number of Institutions	Biologists (18)	Physicists (17)	Social Scientists (17)
1	2	10	4
2	7	3	3
3	4	0	6
4	0	4	1
5	2	0	2
6	1	0	1
7	2	0	0
Average	3.2	1.4	2.8

Source: Data in this table have been taken from The Management of Scientists, Karl B. Hill (ed.), 1964, p. 59.

A survey study, The Mobility of College Faculties, was done by Howard Marshall (1964) as an outgrowth of his need, as an economic department chairman, to find staff for his department. His findings were based on 420 questionnaires returned by department chairmen in the disciplines of economics, English and chemistry. An important matter discussed in Marshall's work was the research on economists done as a doctoral dissertation by Venkatraman Anantaraman.* Some of Anantaraman's findings which might be used in a comparative analysis were that mobility decreases with age, that mobility declines after ten years of working, and that 42% of the economists studied had been employed only in academic

* This work, titled Mobility of Professional Economists in the United States, is in mimeographed form and was done in 1961 at the Industrial Relations Center, The University of Wisconsin.

institutions (Marshall, p. 38). Marshall's criticism of Anantaraman's method of sample selection--drawing 280 economists from American Men of Science--pointed out that criteria for inclusion in American Men of Science would introduce a sample bias toward the characteristics of senior or prominent economists (p. 39). This point of criticism has been influential in the choice of sample selection methods used in the present study. Marshall found that turnover in his respondents' departments was such that "better than 1 out of 7 of the posts had been vacated within the past three years for reasons other than death and retirement." He also found that smaller departments had a higher rate of turnover than large departments and that the associate and full professors combined accounted for one-third of the moves (p. 125).

David G. Brown has done several studies on academic manpower in recent years from the viewpoint of an economist. One study, The Market for College Teachers: An Economic Analysis of Career Patterns Among Southeastern Social Scientists (1965a), was written "primarily for labor economists" and was based on interviews of 150 newly hired professors (economists, sociologists, and historians) in eighteen of the largest Southeastern institutions. Another study, Academic Labor Markets (1965b), culminated in a report to the Office of Manpower, Automation and Training, U. S. Department of Labor and was published in an abridged form as The Mobile Professors (1967). The sample for this study was taken from a universe of "all professors who were newly hired for the academic year 1964-65," and data was collected by questionnaire from 7600 professors, including 447 physicists. Although Brown's findings are based on a large sample, they are limited by the fact that only "newly hired" professors were included and that only one instance of mobility was assess-

ed. A number of the findings from Brown's research will be examined and compared to the findings of the present study in later chapters.

A doctoral dissertation by Elwin F. Cammack (1965a) titled "A Study of Factors Related to Mobility and Faculty Productivity and Achievement at Michigan State University: A Follow-Up Study" reported on research seeking "to determine if faculty members at different levels of productivity and achievement attach varying degrees of significance to different aspects of an academic position." Some significant findings of this research have been summarized by Cammack in an article in Design and Methodology--Institutional Research (1965b):

> The ten factors considered to be most important in the selection of an academic position by the total group of faculty members as determined by mean scores were: (1) relationships with department chairmen: (3) calibre of associates; (3), (4), and (5) academic freedom, the library, and teaching load; (6) reputation of the department; (7) and (8) salary and income potential; (9) time for research; and (10) choice in teaching assignment. . . . A major result of the study has been the re-affirmation of the complexity of the academic market. (p. 67)

The factors which Cammack found to be significant have been incorporated in the study questionnaire design, and his findings have been used in comparative analysis in Chapter V.

Related Findings on Mobility

A number of references were found which deal in part with mobility or which are related to the study of mobility. Two such references, cited in Chapter I, which give a picture of the physics discipline as of a few years ago are: Physics Manpower 1966 edited by Susanne D. Ellis (1966), a publication of the American Institute of Physics, and Physics: Survey and Outlook, the study by the Physics Survey Committee (1966) of the National Academy of Sciences. The first of these contains a wealth of statistics and data tables including a section on"Teaching Faculty."

Although it is described as "a compilation and analysis of data gathered by the American Institute of Physics," its emphasis is on compilation. The Physics Survey Committee report discussed topics such as the importance of basic science to the United States and the essential role of physics in basic science and in technology, trends and patterns in the pursuit of physics research and education, the desirable level of future financial support for physics, and the projected supply of physicists. In the preface to the study one finds the statement, "It is our hope that it provides a sufficiently comprehensive overview of the current state of physics and its most important potentials and requirements for growth."

The factors influencing mobility have been examined in two studies which are found in the literature of higher education. In The Career Decisions of College Teachers, John Gustad (1960) presented results of a study which included teachers in the disciplines of chemistry, English, and psychology from a group of southern colleges and universities. A central focus of the study was the identification, by the teachers interviewed, of "reward values," and a main finding was that "teaching load is one of the most important conditions of work" (p. 37). Gustad used cluster sampling techniques and interviewed 121 college and university teachers. Another geographically restricted study, Job Motivations and Satisfactions of College Teachers, was done in the state of Minnesota by Ruth Eckert and John Stecklein (1961). Findings on job satisfactions were based on a sample of 200 teachers and were derived from an initial hypothesis that satisfactions "tend to center around the nature of the activities they [college teachers] perform rather than the external conditions or rewards" (p. 4).

A study which promises to be a significant contribution to re-

search on higher education faculty is now in progress at Harvard under the direction of Talcott Parsons and Gerald M. Platt.* The pilot study of this research, The American Academic Profession (1968), has been examined. Influences of this work on the present study may be found in the chapters on research design and the analysis of findings. In the concluding portion of the pilot study, Parsons and Platt say:

> We think that, in general, the central reference point of the academic system is commitment to the values of cognitive rationality. Its expression then ranges from the case of clear priority for the "scholar" to various combinations with other value systems for the applied professionals and the teachers of general education. (p. VIII-9)

In discussing cognitive rationality, they note that it "focuses on a boundary relation and interpenetration between the societal and cultural systems" (p. I-12). As a theory construct, this provides a basis for interpreting the findings on mobility as they relate to research emphasis, prestige, and academic freedom.

A reference matrix of research in sociology, economics, and psychology has been found in several books and articles. Two concepts of mobility were discussed in "Sponsored and Contest Mobility of American Academic Scientists" by L. L. Hargens and W. O. Hargens (1967). This work is based on an analysis of a portion of the data collected by Bernard Berelson (1960) for the book, Graduate Education in the United States. In Men and Their Work by Everett C. Hughes (1958), one can find a discussion of the concept of a career and the differentiation between individual and group mobility. From the point of view of the sociology of science, Norman Storer (1966) has written The Social System of Science, a book which he describes as "an exercise in sociological theory build-

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*In a personal communication Professor Platt has expressed the hope that the final report of the study will be available by mid-1969.

ing." His development of a theory of the social organization of science has been useful in developing the theoretical framework of this study, and his work is particularly relevant in the description of the work social system of academic physicists. Although Barney Glaser's (1964) book, Organizational Scientists: Their Professional Careers, is a "case study of the effects of professional recognition on the careers of scientists who work within a medical research organization," its methodology and concepts have contributed to theory development in the present study. A mathematical modeling approach to economic and educational aspects of human resource development is given by Hector Correa (1963) in The Economics of Human Resources. Albert J. Reiss, Jr. (1961) presents results of his studies of some occupations in terms of prestige and a socioeconomic index in Occupations and Social Status. Anne Roe (1956) has written The Psychology of Occupations which she describes as a book structuring "the broad field of the relations between occupation and other aspects of life in search for a general pattern and for basic principles." Also in the area of psychology, Donald E. Super (1957) has published The Psychology of Careers which reports "results of significant recent research and theory development by psychologist, sociologists, and economists." Citations from these works and others of a similar nature may be found in the discussion of a theoretical framework in Chapter III.

Two studies, conducted on a national scale in the United States, which have been used in the analysis of findings are: Work Activities and Attitudes of Scientists and Research Managers: Data from a National Survey by Howard Vollmer (1965) and The Geographic Mobility of Labor by John B. Lansing and Eva Mueller (1967). The work by Vollmer included 973 research physicists and gathered data on type of employer, educa-

tional level, age, and geographic location. The work by Lansing and Mueller was based on 1317 interviews which were drawn to constitute a probability sample of all families in the United States living in private dwelling units, and its analysis was in general terms for all workers.

Several reports of the National Science Foundation which provide a statistical background for the study of the mobility of academic physicists have been examined. The following titles are illustrative of the nature of these reports: (1) The Dynamics of Academic Science (1967a), (2) Science and Engineering Staff at Universities and Colleges 1965-75 (1967b), and (3) American Science Manpower 1966 (1968). The statistical profiles presented in these reports and similar reports from the U. S. Department of Health, Education, and Welfare and the U. S. Department of Labor have been used in analyzing the findings of this study.

A continuation of the discussion of the literature search findings at this point to include minor items and those which are relevant to specific topics such as survey sampling and statistical analysis seems unnecessary. Such references will be cited and briefly discussed at appropriate points in the text of subsequent chapters.

The text of this chapter demonstrates that there is a body of literature with a core of previous research on mobility and surrounding areas of research which relate to mobility. The studies which have been particularly concerned with academic mobility have not emphasized physicists, and those which have included physicists have not focused on job mobility or a time dimension of mobility. The present study has been designed to fill such gaps in the literature.

CHAPTER III

THEORETICAL FRAMEWORK

> The literature on the natural scientist abounds in studies characterizing the scientist in rather general descriptive terms. He is typically viewed generically, and not considered as one functioning in a specific field of science. (Super 1957, p. 15)

Paucity of Theory

Although the quotation given above is from a publication more than ten years old, it points to a fundamental difficulty in finding or expressing a theory of job mobility for physicists. The literature referred to by Super exists primarily in the fields of psychology and sociology and contains for the most part research carried out with only a limited emphasis on theory.

Discussion of the literature search in the previous chapter showed that research has been done on mobility in the last decade, but unfortunately this research has not led to the formulation of a theory of job mobility. Although this discussion of a theoretical framework for the present study starts on a pessimistic note and ends as an unfulfilled quest, it does piece together concepts and approaches from several disciplines to define a useful, if imperfect, frame of reference.

Theory Approach of Some Recent Studies

Examination of the more significant studies done recently on academic mobility provides an indication of a suitable theory approach for the present work.

The title, "The Academic Marketplace," chosen by Caplow and McGee (1958) reveals the emphasis of their approach "to demonstrate that academic institutions are amenable to sociological field study." Their specific focus on the "vacancy-and-replacement process" was described as "an intersection in several planes:"

> There is an intersection between the career of an individual and the history of an institution. There is another intersection between the local system of the university and the national system of the discipline, and still another between the functions of teaching and research. The competing values by which men judge one another and are judged are thrown into high relief in these transactions. (p. 3)

Caplow and McGee considered their work to be an examination of the academic marketplace as a social system.

The studies by Marshall (1964) and Gustad (1960) were derived from a practical or applied interest and made little mention of a theory approach. Gustad did note, however, that:

> It is astounding that so little has been done to apply the knowledge gained from research to the personnel practices of higher education itself. One reason for this is that there has been comparatively little research done on the campuses which would provide the facts and theoretical frameworks needed to improve personnel management in higher education. (p. 5)

In referring to this lack of research, Caplow and McGee noted that many studies done by institutions have not been published because they were oriented toward local problems and considered private documents (p. 19).

In The Market for College Teachers, Brown (1965a) mentioned the difficulty of studying mobility due to its interdisciplinary nature. He saw his study of academic labor markets as cutting across "three more or less distinct areas of literature--educational administration, social organization and social psychology, and labor economics" (p. 7). Brown's

academic training as an economist led him to emphasize theories of labor economics, but he concluded that "solely economic theories explain neither the current distribution nor the direction of mobility in academic labor markets" (p. 263).

The research by Parsons and Platt (1968) has several threads of theory in its fabric, mostly from the discipline of sociology. They speak of "a reference point . . . the nature and determinants of different social structures and their relative incidence within the larger society," and they emphasize an "associational" type of structure in contrast to the "bureaucratic" type (p. I-1). They also refer to a theoretical focus concerning "the special properties of social systems intimately related, through interdependence and interpenetration, with cultural systems" (p. I-3).

If a commonality of theory approach can be identified in these studies, it is a concern with social systems that is expressed either explicitly or implicitly. Interwoven into this social systems theory approach are elements from psychology, educational administration, economics, and social psychology; and interestingly enough, concepts now used in the social sciences which have their theoretical base in physics.

Theory Approaches in Research Related to Mobility

In Scientific Careers and Vocational Development Theory, Donald E. Super and Paul B. Bachrach (1957) present three theory approaches: (1) trait-and-factor theory, (2) social systems theory, and (3) personality theories (pp. 100-122). Trait-and-factor theory, which is identified as the classical approach, is described as having a basis in the psychological theory of individual differences and being concerned with the individual personality traits or factors which are believed to be the

determinants of success in an occupation. Social systems theory is characterized as an approach which places an "emphasis upon the dynamic interaction of the individual with the social systems which impinge on him, and upon the interaction of these social systems with each other" (p. 104). Personality theory approach is actually an envelope description for many approaches, each of which assumes a particular personality theory as a base. These approaches use concepts such as "personality structure," "implementation of the self-concept," and "need satisfaction," and they focus on the hereditary, environmental and experiential variables which combine to produce personality. Super and Bachrach contribute by integrating the three major approaches into a "vocational development theory."* They conclude after their evaluation of the literature that:

> Theory has not been altogether lacking, although it has not been a major concern. Research has been based largely on trait-and-factor theory derived from the psychology of individual differences and from a static approach to social factors. . . . Other theoretical orientations have . . . stressed the influence of social systems or have drawn from personality theory . . . . Much of the literature is based on subjective and non-quantified observation, such as personal experience and impressionistic biographical study. The nonscientific approach to research on scientists is obviously somewhat incongruous. (p. 6)

Storer has taken as a basic definition of a social system one given by Floyd Allport:

> Any recognizably delimited aggregate of dynamic elements that are in some way interconnected and interdependent and that continue to operate together according to certain laws and in such a way as to produce some characteristic total effect. (Storer 1966, p. 29)

Storer discusses the social system of science in terms of an "exchange model" in which the pattern of interaction is organized about a "com-

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*This theory expressed as a group of twelve propositions is given in appendix I.

modity" which is exchanged according to a shared set of norms or standards (pp. 32-33). He credits Robert K. Merton with identifying the "comodity" for science as "professional recognition," (Storer, p. 19) and notes that Barney Glaser has given the following list of varied forms which professional recognition may take:

> . . . eponymy, prizes, awards, fellowships, scholarships, honorary memberships and committee work in scientific organizations, editorships, honorary degrees, professorships, chairs, lectureships, consultantships, mention by historians of science, publication, acknowledgement in other's work, and evaluations by colleagues. (Storer, p. 21)

In Occupational Sociology, Lee Taylor (1968) sets forth a number of concepts that are useful in theory development. He takes as a basic definition of occupation:

> That specific activity with a market value which an individual continually pursues for the purpose of obtaining a steady flow of income; this activity also determines the social position of the individual. (p. 8)

He elaborates on this definition by emphasizing its sociological aspects as "a patterned set of human relations having to do with specific work experiences", and he notes that the sociological concept of occupation includes as integral components "career, status, prestige, mobility, images, clients, culture, structure, recruitment, remuneration, and control" (p. 10). According to Taylor, the terms occupation, position, and job may be differentiated by placing them along a scale of specificity from low to high; for example, one's occupation would be physicist, one's position would be academic physicist, and one's job would be associate professor of physics. With particular consideration of occupational mobility Taylor suggests that:

> Three types of occupational mobility may be enumerated: a change in position in relation to one's colleagues, shifting from one occupation to another, and the increasing or decreasing in prestige of a total occupation. (p. 63)

The first type listed is the primary concern of this study. In discussing occupational mobility (pp. 62-86), Taylor makes no reference to mobility studies of physicists and notes that occupational mobility is "a widely discussed phenomenon" which is little understood "though many emotional expressions have been put forth in its defense" (pp. 82-3).

Eli Ginzberg (1966), in The Development of Human Resources, writes from a viewpoint of having integrated the intellectual and social forces "which together help to explain why concern with the human resource factor in economics has moved only recently from a position where it was neglected or elicited only casual interest into the middle of the arena." He identifies a "starting point in economics, . . . developments from the field of psychology, . . . certain characteristics of advanced technological societies, . . . the evolution of democratic thought and action" and concludes that these elements interact to bring about the emergence of "a new discipline--the discipline of human resources" (p. 1). In discussing the development of human resources, he notes that little is known about people's ongoing work experience in comparison to their preparation and initial choice of an occupation (p. 58). Ginzberg proposes a theory model for occupational development for which he says:

> In developing this description attention will be devoted to three dimensions of the process: the direction, progression, and continuity of the individual's work history. (p. 59)

The dimension of direction is concerned with the relationship between an individual's present work and his original occupational goals. The dimensions of progression concerns an individual's movement through an established hierarchy of jobs such as from instructor to professor. The continuity of a work history is evaluated in terms of the number and degree of interruptions such as military service, illness, etc. From

personal research he identifies three basic career patterns--straight, broad, and variant. The straight pattern can be illustrated by an individual who begins his higher education as a chemistry major, continues through a Ph.D. degree, and spends his work life as an industrial chemist. An individual who began his career with an engineering degree, worked in industry for a while, returned to education to complete a Ph.D. in physics, and completed his work life as a university faculty member would evidence a broad pattern. The individual whose work life is characterized by radical changes or a lack of progression would be considered to have a variant pattern (p. 60). In a general comment of analysis he observed that:

> With respect to fields, those with careers in the natural sciences are overrepresented in the straight pattern, and those in the humanities and business are overrepresented in the variant pattern. . . . There was overrepresentation of the straight pattern in academic life, of the broad in corporate enterprise, and of the variant among the self-employed. (pp. 67-68)

In Occupational Careers Walter L. Slocum (1966) presents an eclectic view of the sociology of occupations. His concepts of occupation, career, etc., differ only in minor ways from those discussed previously, but he does include a concept of work organization which he describes as "social systems organized to perform work of various kinds and in which members perform specialized work required to produce ideas, goods, or services--networks of relationships among persons who perform work and other activities that are expected because they hold certain positions" (pp. 4-7). With respect to career mobility, he discusses college and university professors in A. W. Gouldner's (1957) terms as "locals" or "cosmopolitans," (p. 249) groupings which correspond roughly to Ginzberg's "straight" and "broad" career patterns.

Choosing a Reference Frame

The search for a theory of job mobility outlined in the previous section with citations from the literature has no conclusion. The complexity of viewing an individual as he exists in time and as he moves spatially from one job to another has been indicated by recording how the phenomenon has been approached from several disciplines, with a variety of techniques, and with a multiplicity of concepts. In theorizing, the individual and elements of his job situation can be abstractly viewed and described, but the mechanism of mobility remains unclarified. The mobility mechanism could be examined with an emphasis on the individual who moves, on the social matrix which provides the context of movement, or upon the intersection of these two reference frames.

Robert Perrucci has examined the mechanism in terms of values held by the individual and comes to a dead-end of not being able to say "whether certain value patterns are essential for mobility or are a consequence of it" (1967, p. 115). He argues that:

> Social mobility is best viewed as a result of a complex pattern of relationships between the objective opportunity structure of a society, individual values, beliefs, and aspirations concerning elements of the opportunity structure and the structural settings within which the individual is influenced and within which his personal views are reinforced, modified or challenged. (pp. 118-19)

In relation to examining individual values, Hughes has observed that the language about work is so loaded with "value and prestige judgments" that the concepts expressed by social scientists may be blinders to scientific discourse (1958, p. 43). If one focuses on the individual value patterns, attention must be given to the psychological research data such as has been compiled by Roe (1964, 1956, 1953), Super and Bachrach (1957), and Eiduson (1962). Such research has found that scientists generally

represent a middle-class value system, have had fathers who were professional men, are achievement motivated, accept deferred gratification, value knowledge for its own sake, have strong inner-directedness, are introverted, show asocial tendencies, show controlled intellectuality, and are excellently endowed with intellectual capacities. Studying the mobility mechanism in terms of psychological concepts and placing an emphasis on values becomes something of a morass in the sense that Lawrence S. Kubie (1962) has pointed out:

> I cannot overemphasize the importance of keeping the fact in mind that human behavior is like a centipede, standing on many legs. Nothing that we do has a single determinant, whether conscious, preconscious, or unconscious. (p. 207)

An emphasis on the "opportunity structure of a society", which may be thought of as a collectivity of individual values, similarly leads to an unmanageable task which Neil J. Smelser (1963) has described by saying:

> Widespread disagreement among sociologists about the fundamental problems and concepts of their discipline has led to a mushrooming of variables. Because of this superabundance, sociological analysts are unable to present simple and coherent models; instead, analysis often focuses on categorizing social facts. (pp. 26-27)

Both the psychological emphasis on human behavior and the sociological emphasis on the social structures seem to be low efficiency reference frames for examining mobility due to their characteristic diffuseness and multiplicity.

The interest in higher education and the possible use of study findings by administrators, noted in the introductory chapter, suggests that a reference frame be selected which contains variables and concepts that can be readily assessed by an academic administrator. The interface between the human behavior and social structure reference frames, where

one finds a mobile individual as a focus of social systems, seems an appropriate choice. The essential phenomenon to be examined at this interface is a complex pattern of relationships defined by factors of influences, and in theory approach this is most nearly that of the social systems approach described earlier in this chapter from the work of Super and Bachrach. The systems or social structures may be identified according to the "usual basis for classifying . . . the basic functions they serve--political, economic, familial, religious, educational" (Smelser 1963, p. 28). The factors defining a pattern of relationships are a combination of social and psychological influences which bring about mobility.

Extension of this choice of a reference frame into the building of a research model will be attempted after defining some terms and concepts for the research model.

Terms of Reference

The major terms of reference used in this study will be defined or at least circumscribed in this section. These terms or concepts include physicist, academic physicist, career, occupation, position, job, mobility, and higher education institution.

Who Is a Physicist?

One would like to be able to give precise definition to the term "physicist" by identifying a particular body of knowledge and then saying that a physicist is a person who in his work activities is concerned with this knowledge, but examination of textbooks whose titles proclaim that they are about physics soon reveals that there is no clear identification or agreed upon definition of physics. Physics is at the same

time a static record of man's concerns with his natural environment and a dynamic activity of people who are today seeking truths about the physical universe on many levels. The view can be found that the static record and classical subjects of interest should be considered as physics history and that present research activities be seen as "real" physics. On the other hand, physics doctorate holders who teach in a liberal arts college with little opportunity for research or who have taken on administrative responsibilities would prefer a broader definition which allows them an identity as physicists. Other aspects of difficulty exist in defining physics because of its fundamental and broad scope which has led to an inclusion of segments of physics knowledge in the domains of chemistry, engineering, biology, etc. In that portion of the physics domain called theoretical physics the difficulty of physics overlapping mathematics arises, and the portion of physics knowledge that is called applied physics similarly points out difficulty where the same knowledge in a different context may be called engineering.

For purposes of this study a physicist can be generally defined by making an analogy to the Bohr model of an atom, which in gross terms is a central matter core surrounded by a number of energy levels. Compared to the center of an atom, one could say that physics as a body of knowledge has a core which includes subjects such as mechanics, electricity and magnetism, light, heat and sound. An individual whose activities concern these subjects or their derivatives at an immediate level is, with only a small probability of refutation, a physicist. Moving to the comparison with surrounding energy levels, one could say that there are many activities which are concentric to the core and which involve physics knowledge, but the probability that the individual in these ac-

tivities is called a physicist is less certain. Finally, at a level effectively an infinite distance away from the core the identity of an individual as a physicist diminishes to zero probability. This non-physicist could be thought of as an individual who is closely associated with another knowledge core such as English or history. In essence, the physicist generally is and does a wide variety of things.

When a more specific definition of physicist is needed, one may use the criterion of the National Science Foundation for inclusion in the National Register of Scientific and Technical Personnel. This criterion considers an individual to be a physicist if he has "a bachelor's degree plus 2 years of additional training or professional experience; or the equivalent in professional experience" (1968, p. 203).

What Is an Academic Physicist?

Having viewed the physicist as a person with a particular academic preparation and/or experience whose work activities relate to particular knowledge called physics, the adjective "academic" is considered to qualify this view by placing the individual in a particular context of social organizations called institutions of higher education.

The operational definition that has been used in the study is based on the assumption that anyone listed in the American Institute of Physics Directory of Physics and Astronomy Faculties 1967-1968, as a member of a department other than astronomy, is an academic physicist. This definition does not imply that the individual work activity is teaching and/or research; it simply denotes a job context.

Career-Occupation-Position-Job

The four terms--career, occupation, position, and job--are used in the literature in a variety of ways. Generally, the term career is

used as the broadest or most inclusive concept. Howard S. Becker describes it as "a patterned series of adjustments made by the individual" to the "network of institutions, formal organizations, and informal relationships," and notes further that:

> This series of adjustments is typically considered in terms of movement up or down between positions differentiated by their rank in some formal or informal hierarchy of prestige, influence, and income. (1962, p. 321)

Joel Gerstl adds to this concept by emphasizing that a succession of positions includes "movement into and out of the work world," (1967, p. 228) while E. C. Hughes places an emphasis on the "network" by saying "that the career of a man is worked out in some organized system without reference to which it cannot be described, much less understood" (1958, p. 8). Hughes notes that in a free society individuals have more latitude to choose or create their positions. The free society, which is an unstated contextual assumption for this study, is epitomized by Hughes with the comment:

> There are more adventurers and more failures, but unless complete disorder reigns, there will be typical sequences of position, achievement, responsibility, and even of adventure. (p. 63)

The "typical sequences" or "patterned series of adjustments" have been the emphasis of some researchers. In this case, the term career pattern is used frequently in the sense Super has described:

> The term career-pattern originated in the field of sociology, in the study of social mobility by means of occupational mobility. It closely parallels, both in meaning and time, the psychological concept of life stages. (1957, p. 71)

Super gives credit to Charlotte Buehler for definition of the life stages as: (1) growth--ages 1-14, (2) exploratory--ages 15-25, (3) establishment--ages 25-45, (4) maintenance--ages 45-65, and (5) decline--age 65 plus (p. 71). In summary for the term "career," one may say that this

term is most often the one used to denote generality of work situation although it is interchangeably used by some along with "occupation," "position," or "job."

The term "occupation" is used by Roe "to mean whatever an adult spends most of his time doing" (1956, p. 3) and is defined by Slocum as "the kind of work an adult does on a regular basis . . . for wages, salary, commissions, or other form of money income" (1966, p. 4). These uses of the term focus on the time dimension of an individual's activities and make no attempt to relate it to a spatial dimension. Super uses an interlocking set of terms to define occupation and brings in the spatial dimension as follows:

> An occupation is a group of similar jobs in several establishments.
>
> A job is a group of similar positions in one plant, business, institution or other workplace.
>
> A position is a set of tasks performed by one person. (1957, p.8)

This set of terms reduces basically to a concept of individual activity, but in contrast to the previous definitions, it emphasizes the spatial rather than the temporal dimension. This use of the terms job and position is just the reverse of that indicated by Taylor (1968) since in specificity job is taken to be a more general term. Although all four work activity identifying terms--career, occupation, position, and job--are interchangeably used at times, the most frequent disagreement noted in the literature where careful usage is made is that between job and position according to specificity. Eckert and Stecklein have outlined their use of terms by saying:

> The terms "occupation," "job," and "position" are used . . . to suggest progressively narrower definitions of work activities. All individuals who hold academic positions in recognized higher

> institutions are classified in the Dictionary of Occupational Titles as "Teachers, college or university" . . . "job" is a much more specific term . . . since it normally designates the work expectations set for "a composite of positions" within any occupation. . . it might refer to the services expected of teachers in particular disciplines, . . . The term "position" is usually reserved for a specific job; i.e. serving in a given institution with a uniquely defined set of responsibilities. (1961, p. 2)

Inasmuch as the title of this study includes the term "job," additional comment giving its operational definition is needed. Conceptually, it is viewed in the framework of work specificity, as by several of the authors discussed above, and it is understood to have temporal and spatial dimensions. If placed along a spectrum of specificity of work activity ranging from "complete specificity" to "no specificity," it would be found in a position closer to the "complete specificity" end of the spectrum. Operationally, it is defined by the academic physicist's perception of his "primary activity in a time sequence" which he records as a separate entry on the study questionnaire.

Mobility

Mobility may be defined as a temporal and spatial change of some entity, and job mobility, in particular, may be described as the movement in time and space of an individual's primary work activity.

A brief elaboration as to the nature and mechanism of mobility may clarify the term as it is used in this study. Following Hughes' identification of kinds of mobility, the concern of this study is for "individual" mobility in which:

> The individual makes the several choices, and achieves the skills which allow him to move to a certain position in the occupational, and thus--he hopes--in the social and economic hierarchy. (1958, p. 44)

This kind of mobility is to be contrasted to "group" mobility in which whole occupations change their position in a social structure. Slocum

notes that individual mobility "may involve promotion to a more responsible position, demotion, discharge, moving to another organization, or retirement," (1966, p. 239) while Gerstl points out that job changes may not be "related to each other in a coherent manner" (1967, p. 229). Ralph H. Turner emphasizes the mechanism of mobility by describing two types:

> Contest mobility is a system in which elite status is the prize in an open contest and is taken by the aspirants own efforts . . . . Under sponsored mobility elite recruits are chosen by the established elite or their agents, and elite status is given on the basis of some criterion of supposed merit and cannot be taken by any amount of effort or strategy. (1961, p. 122)

The job mobility of academic physicists can be considered to have both contest and sponsored elements. In the sense that an individual can gain recognition and subsequent jobs through his academic record, publication, and research, his own efforts bring about elite status. But on the other hand, achieving a status academic position really is for the most part by invitation or under sponsorship.

Higher Education--Institution--Organization

The term "higher education" has been used in the general sense to identify any educational activity that exists for the participation of individuals who have completed a secondary or high school program. As a concept it is viewed as an institution in accord with the following description:

> The concept, institution, refers to social arrangements of life in human societies. These are the procedures by which societies organize and regulate their social and cultural activities to meet the necessities of individual and collective existence, and to persist through time. (Sirjamski 1967, p. 36)

More specifically, as regards its usage in this study, it is viewed as a composite of complex organizations--universities and colleges--which

provide specific activities such as the study of physics. In this sense, specific institutions of higher education which provide the spatial setting for job mobility may be described as follows:

> A complex organization consists of (1) stable patterns of interaction, (2) among coalitions of groups having a collective identity (e.g., a name and location), (3) pursuing interests and accomplishing given tasks, and (4) coordinated by power and authority structures. (Corwin 1967, p. 161)

The Research Model

Drawing on the aforementioned literature and having in mind the other literature which Super has called "fragmentary" due to their limited perspective, (1957, p. 89) the following theoretical model of the academic physics social subsystem has been constructed.

Employment of academic physicists in institutions of higher education offering a physics major can be envisioned spatially with dimensions of prestige (P), employers (E), and jobs (J) as shown in figure 2. Career lines in this space would have an origin at a given prestige level (that of the institution awarding the highest degree) and would have as a first segment the subcomponent defined by the two general points, (E_0 , J_0 , P_1) and (E_1 , J_1 , P_2), which respectively specify the starting point of a career--zero employer, zero job, prestige of degree institution--and the point of first employment--first employer, first job, prestige of first employer institution. The dimensions of employers and jobs, in principle, have no upper limit, but they will usually range from ten to fifteen units. The prestige dimension will have an upper limit which corresponds to the one most prestigeous institution that exists at a particular time the space is calibrated in its evolution as a time-developing open system in which new prestige

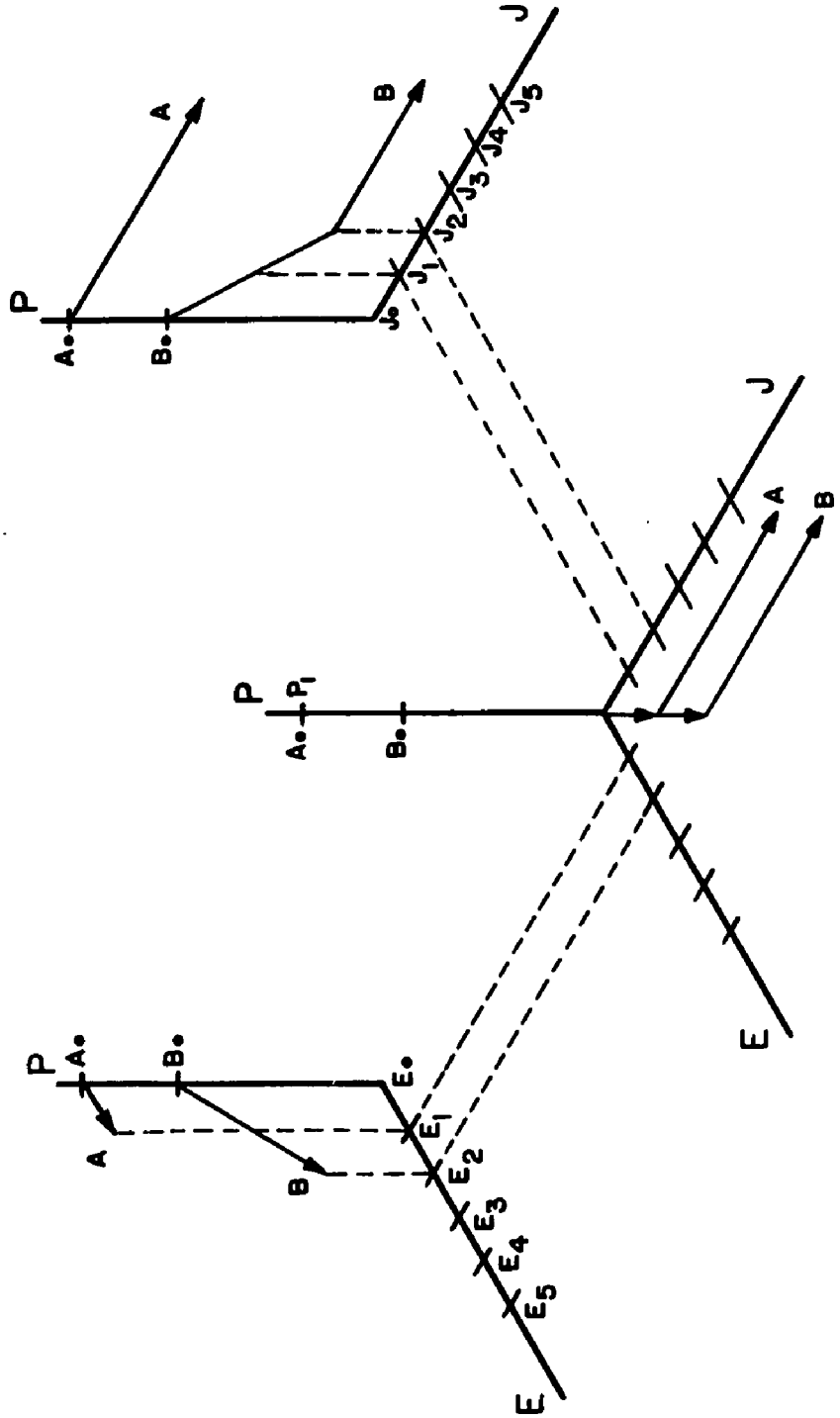


Fig. 2--Prestige Space

levels, employers, and jobs may be created. Calibration of the prestige dimension can be thought of as the variety of ways prestige may be assessed as well as time variants of a given method of assessment. As the space has been conceptualized only for prestige assessment of academic institutions, other types of employment (if included in the presentation of a career line) would be placed in the P = 0 plane. Two examples of career lines are shown by means of their projections onto the three planes P = 0, E = 0, and J = 0. The first example, line A, shows a career origin (E_0 , J_0 , A_0) with $A_0 = P_1$ signifying the prestige of the degree granting institution attended by individual A. The projection lines describing the career of A as seen in the three planes show that the individual involved stayed at the same level of prestige with one employer for a number of jobs. Example B shows an individual who goes down in the prestige level for his first employment, holds one job with this first employer, takes a second job with a new employer which is at a still lower prestige level, and then continues with that employer for several jobs.

Positions in prestige space may be occupied by multi-component entities, the individual academic physicists, who may be viewed as personality envelopes enclosing influences, traits, values, abilities, needs, etc. The envelopes, like the prestige space, are considered to be time-developing open systems, and they are assumed to be dominated at a given time by only a few components while the others are in recession. The components are considered to represent and/or include the interactions of the individual with the major social systems of family, education, and work. Dominant components represent the individual's perception of major needs, influences, or motivation, and they are the root

cause of movement in the prestige space. These dominant components may be brought forward by change within the prestige space, by change in the interaction of the individual and his social systems, or by change in the social systems themselves.

The fundamental assumption of the research model is that job mobility of academic physicists can be studied in the framework of the interaction of social systems and subsystems which produce perceived needs, influences, or motivations. The mechanism of mobility is pictured primarily as a process analogous to "economic rationality" which has been described as:

> One of the most important "givens" in traditional economic analysis is that of economic rationality: If an individual is presented with a situation of choice in an economic setting, he will behave so as to maximize his economic position. (Smelser 1963, p. 26)

Caplow and McGee have referred to the "principle of the conservation of status" as an underlying mechanism of mobility noting that:

> Gains of status are usually, but not always, sought by the incumbents of organizational positions. Losses of status are always resisted. (1958, p. 155)

In short, job mobility is considered to result from an individual's cognitive, rational choice under conditions of social system influence which will maximize his prestige position.

In the following section, a transition will be made from the theory model to measurable variables and testable hypotheses which are consistent with the delimited problem statement set forth in Chapter I.

Variables, Parameters, and Hypotheses

The major variables to be recorded by means of the research questionnaire are the time and physical location of the individual physicist's work activity. These variables are supplemented by others which characterize the individual as a member of a given social system. For

the family social system the respondent is asked to record marital status and number of children; for the educational system, the degrees received; and for the work system, the work activity, publications, other productivity, title of work activity, and tenure status.

Analysis of the data collected will result in estimation of population parameters which characterize academic physicists in several ways. A basic evaluation will be the calculation of means and standard deviations for the variables used so as to give a statistical profile of academic physicists in terms of age, marital status, work activity, etc. As an assessment of job mobility the data will be summarized also in terms of frequency plots, categorizations, correlations, and statistical measures such as chi-square, predictive association, and Cramer's statistic. As a measure of the academic physicist's perception of the influences of the major social systems on his job choices, a profile of job choice influence factors will be prepared. Details of this analysis of population parameter estimation may be found in Chapter V.

A number of hypotheses which have been drawn from the literature and the theory model will be tested. Consideration of hypotheses has been limited to the influence of social systems on job mobility only after the individual has completed a level of higher education. This neglect of the impact of social origins on later life job choices is taken to be in accord with the viewpoint Perrucci has stated:

> Although it is certainly recognized that social origins do affect the likelihood that a person will gain access to the means for mobility, it is often maintained that the negative effects of social origins are "neutralized" among those who manage to complete a higher education. (1967, p. 117)

Preceeding from the assumption that higher education degrees are indicators of performance which merit professional recognition, one may frame

the hypothesis that an individual who attains a higher education degree will be sought out and would therefore be more mobile than individuals holding lesser degrees. This may be stated as follows:

HYPOTHESIS I--Mobility increases as the level of higher education degree attainment increases.

A refinement or extension of this hypothesis may be stated in terms of the prestige of the degree awarding institution as suggested by Hargens and Hargens (1967). Their conclusion stated as an hypothesis is:

HYPOTHESIS II--The prestige of the institution where an individual receives his degree correlates with the prestige of his employing institution even when the effects of his productivity are considered.

Although the degree-awarding institution appears to be an important factor in the subsequent prestige job attainment, Brown (1967, p. 100) has pointed out that the volume of doctorates is so concentrated in the more prestigious institutions that the basic interprestige movement from degree institution to employment is of necessity in a direction downward in the prestige hierarchy. He notes also that "rapidly expanding disciplines, such as mathematics, physics, and mechanical engineering" provide a context where the probability of upward prestige movement is enhanced (1967, p. 102). An hypothesis to be tested for academic physicists in this matter may be expressed:

HYPOTHESIS III--The basic pattern of job mobility as revealed in interprestige movements is in a direction down the prestige hierarchy.

Brown (1967, p. 101) has also indicated that high publication productivity correlates with at least an arrestment of the basic downward pattern and in some cases results in a reversal or pattern of upward movement in the prestige hierarchy. This idea can be stated as:

HYPOTHESIS IV--High publication productivity correlates with a stable or upwardly directed pattern of interprestige movement in the prestige hierarchy.

Once an individual is in the work social system of academic physics, the mechanism of tenure would appear to be an important factor influencing his mobility. Brown found that "the mobility of tenured professors is lower than that of the nontenured, even after a correction is made for age difference" (1967, p. 52). One can test the hypothesis that mobility decreases after a tenured position is attained:

HYPOTHESIS V--An individual's job mobility decreases after the attainment of a tenured position.

Another relationship that may be tested in regard to decreasing mobility is the influence of increasing family responsibilities. One might test the hypothesis that marriage would bring about a decline in mobility, and further that an increasing number of children would create an even stronger influence on maintaining a given employment situation. In their study of geographic mobility, Lansing and Mueller (1967, p. 150) concluded that "people's preferences about location are strongly influenced by family ties and ties to friends," and assembled data which showed greater mobility for single persons. Community ties which develop through responsibilities for children's schooling and care would seem likely to add a factor which works toward decreased mobility. As an hypothesis this could be:

HYPOTHESIS VI--Job mobility decreases as an individual's family responsibilities increase.

A final hypothesis to be tested can be described as a cultural influence. Reiss has noted that "persons forty years old and over are the least mobile age group" (1961, p. 185). The hypothesis to be tested would be simply that:

HYPOTHESIS VII--Job mobility decreases with age.

The hypotheses given above have been selected to test whether or not the family, educational, or work social systems have a measurable effect on the job mobility of academic physicists. If the hypotheses prove to be acceptable at a level of confidence of 0.05 or better, the concept of interacting social systems as the underlying mechanism of mobility will have been validated and a base for further research will have been established. Acceptability of some hypotheses and rejection of others may provide selected systems or subsystems which seem worthy of further research, whereas complete rejection of the hypotheses will show that a social systems approach to the study of job mobility has limited value.

PART II. THE STUDY

CHAPTER IV

RESEARCH DESIGN

Survey Research Methods

In choosing a research methodology for the study of job mobility, it was decided that the subject most nearly conforms to research techniques which Bernard Berelson and Gary Steiner (1964) have discussed in Human Behavior: An Inventory of Scientific Findings. In their discussion three designs have been singled out as the major methodologies of behavioral sciences: "the experiment, the sample survey, and the case study" (p. 18). Weighing the advantages and disadvantages noted by Berelson and Steiner (pp. 19-34) for the various methodologies and their associated techniques in the context of available resources, it was decided that survey sampling methods, using a mail questionnaire as the research instrument, would be the most feasible approach to the study of job mobility.

A. N. Oppenheim has presented the advantages and disadvantages of the mail questionnaire in these terms:

> The chief advantage of the mail questionnaire is cheapness . . . . It does not require a trained staff of field workers. . . . The processing and analysis are usually also simpler and cheaper than in the case of interviews. . . . The fact that no interviewer is present means that there will be no interviewer bias. . . . A mail questionnaire cannot hope to cover people of low intelligence or of very limited educational background. . . . By far the largest disadvantage of mail questionnaires, however, is the fact that they usually produce very poor response rates. (1966, pp. 32-34)

The advantages noted by Oppenheim clearly relate to the present study and

speak for themselves, and since the population to be studied has been well-educated and is of high intelligence the disadvantages noted have been only a minimal concern. The poor response rate aspect was off-set by raising the sample size to approximately double that required for the chosen level of precision in the survey results.

As the study was not conducted with a purpose to provide a basis for specific and immediate decision in the context of an academic organization, the setting of a level of precision for the survey results has been for the most part a matter of choosing the level most commonly used--a five percent level of precision (Moser 1958, p. 68). C. A. Moser (1958) notes that the precision required relates "to how, and by whom, the results are to be used and how much hinges on the decisions which they will determine" (p. 117). Leslie Kish has well described the study situation, which apparently is a common one, in his book Survey Sampling:

> The utilization of survey results may sometimes take the form of specified decisions, based on the survey results and other relevant information. More frequently, the results become part of the public fund of knowledge and the researcher has only vague understanding of the future use of his results. . . . More often the survey aims are many and vaguely stated, yet the researcher can find some broad limits of desired precision. Commonly, however, instead of specifying precision, the researcher must work from a reasonable allowed expenditure, and adjust accordingly the aims and the scope of the survey. This occurs in the design of surveys with many objectives, none of which is of predominant importance. (1965, p. 4)

These aspects of utilization, available resources, and the objectives of estimating population parameters and testing hypotheses have been discussed in the introductory chapters of this study.

The broad elements of the research design have included specification of the study population, selection of samples, construction of the questionnaire, a pre-test distribution to a pilot sample, distribution and collection of questionnaires with follow-up techniques, and compilation

and analysis of data. The resources of the University of Michigan's Statistical Laboratory and Computing Center have been utilized in the latter phase of the design in keeping with the observation of C. H. Backstrom and C. D. Hursh:

> For analyzing survey results, the use of electronic data-processing equipment is virtually a must for any kind of rapid cumulation and association of multitudinous data. (1963, p. 16)

Detailed consideration of the individual phases of the research design is presented in the following sections.

Population and Sampling

Kish has outlined the concepts and terms of definition for identification of a sample survey population. He notes that:

> The elements of a population are the units for which information is sought; they are the individuals, the elementary units comprising the population about which inferences are to be drawn. They are the units of analysis, and their nature is determined by the survey objectives. . . . The population is defined jointly with the elements: the population is the aggregate of the elements, and the elements are the basic units that comprise and define the population. The population must be defined in terms of (1) content, (2) units, (3) extent, and (4) time. (1965, pp. 6-7)

In Kish's terms the study population is all academic (content) physicists in higher education institutions offering a physics major (units) in the United States (extent) as listed in the Directory of Physics and Astronomy Faculties 1967-68 (time).

A purposive sample was selected for use as a pilot group in pretesting the research questionnaire.* This sample included fifty academic physicists who were chosen so as to have a range of ages, academic ranks, geographical locations, size of employing institutions, and institutional

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*Purposive sampling is described as picking "cases that are judged to be typical of the population in which one is interested (Selltiz 1967, pp. 520-21). The individuals were selected primarily on the basis of the author's personal knowledge of their characteristics.

prestiges. From the author's personal acquaintance with a majority of the respondents, ages were estimated to give a distribution with approximately 40% in their thirties or less, 40% in their forties, and 20% in their fifties or over. According to their listing in the Directory of Physics & Astronomy Faculties 1967-1968, nineteen professors, sixteen associate professors, twelve assistant professors, and three others were selected. The geographical locations of the respondents were primarily in the North Central and South census regions, but some were also included from the Northeast and West regions. The size of employing institutions ranged from 674 to 41,809 students with a median enrollment of 5569. Classified by highest level of training, 46% of the employing institutions awarded doctor of philosophy and equivalent degrees, 37% offered master's and/or second professional degrees, and 17% offered only the bachelor's and/or first professional degrees. The prestige of the employing institutions, as designated by Brown (1965b) in Academic Labor Markets,* ranged from the highest to the lowest prestige groups.

The main sample was later chosen to be a stratified random sample drawn with a uniform sampling fraction. Stratification was made according to academic rank upon the evidence of findings that "an individual's mobility is concentrated in the lower ranks and more limited in respect to senior positions" (Brown 1967, p. 51) and that both "free and compulsory mobility" vary according to rank (Caplow and McGee 1958, p. 35). A uniform sampling fraction was used since no evidence was found in the literature which would provide a criterion for variable fractions accord-

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* Data on institutional size and classification were taken from Education Directory: 1966-67, Part III, U. S. Department of Health, Education, and Welfare (1967). Brown's prestige rankings were based on quantitative data such as number of faculty, students, library volumes, and financial statistics (see appendix IV for a complete discussion of his rankings).

ing to academic rank. The process of stratification was used to improve the precision of the sample results, and the process of random selection was used to reduce sampling bias and to allow the use of certain statistical assumptions in later analysis (Moser 1958, pp. 75-84).

The sample size was set at 800 units according to the following analysis. As a base criterion, the sample precision was chosen to be a five percent confidence level assuming that this level would be adequate for the possible usage of sample results by administrators as partial determinants in decisions related to academic physicists. The estimation of the central population parameter, the total number of jobs held by an academic physicist during his career, was chosen as the result to be given priority and to provide a basis for sample size. With the further assumption of a simple random sample, the sample size (n) was estimated from statistical theory which defines it as the ratio of the square of the standard deviation (s.d.) to the square of the standard error (s.e.) (Moser 1958, pp. 116-119). An approximate value for the standard deviation was determined to be 0.9 from three studies reported in the literature: (1) Roe's finding of 1.4 jobs for physicists after the receipt of their Ph.D. (1963, p. 59), (2) a National Education Association study report of 2.2 as the mean number of institutions in which faculty members had taught (1966, p. 9), and (3) a finding of 3.5 moves as the average for a sample of 1000 professors reported by M. Shimbori (1964, p. 287). Calculation of an approximate sample size was then made according to the equation:

$$n = \frac{(s.d.)^2}{(s.e.)^2} = \frac{(0.9)^2}{(0.05)^2} = \frac{0.81}{0.0025} = 325 .$$

Considering non-response, stratification of the sample by academic rank, improvement of precision with an increase of sample size, and the practical limitations of costs in conducting the survey, the sample size was then set at 800 units. Design criteria for the sample met those given by Backstrom and Hursh in their observation:

> So the task becomes that of designing a sample that is a compromise between the strict demands of theory and the practical limits of funds. A good (efficient) probability sample, by practical definition, is one that yields the desired information within expected but tolerable limits of sampling error for the lowest cost. . . . Cost is the overriding consideration in surveying. (1963, pp. 24-25)

Assuming a 20% non-response rate (Moser 1958, p. 119) the sample was expected to yield about 200 returns from professors and assistant professors, about 150 returns from associate professors, and about 80 returns from others.*

The Questionnaire

The study questionnaire was designed with Oppenheim's view of its nature in mind:

> A questionnaire is not just a list of questions or a form to be filled out. It is essentially a scientific instrument for measurement and for collection of particular kinds of data. Like all such instruments, it has to be specially designed according to particular specifications and with specific aims in mind, and the data it yields are subject to error. (1966, p. 2)

Within the theory framework chosen for the study, three areas of data needed to be measured: (1) personal characteristics of the physicists which related them to the educational, work, and familial social systems, (2) a time sequence record of employment from a baseline of a bachelor's

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*These estimates were based on the percentages of faculty listed in the Directory of Physics & Astronomy Faculties 1967-1968 by rank: professors--31.6%, associate professors--22.9%, assistant professors--32.6% and others--12.7%.

degree education, and (3) the physicist's perceptions of social system factors which influenced his job mobility.

Assuming a respondent's interest could be gained by the research topic, the questionnaire length was kept to a minimum and its organization tightly structured to maintain interest and the likelihood of completion and return. It was possible to limit the questionnaire to four pages with three parts and no more than six sub-parts (see appendix II). The three parts corresponded to the three data areas previously mentioned and were titled: Part I. Personal Data; Part II. Education-Employment Flowchart; and Part III. Influence Factors in Employment. Sub-parts of Personal Data included a personal events list such as date of birth, marriage and birth of children; a work activity profile in terms of percentage of working time devoted to teaching, research, administration, and other; and a productivity record of publications and other activities. Part II was designed as a flowchart so that each individual's consideration would be personalized as he filled in his employment history under the broad groupings of academic, non-academic, and other activities. Provision was also made for interspersal of education and employment or for concurrent activities of work and education. Test blocks were incorporated into the design so that an individual needed only to examine those flowchart blocks which were pertinent to his particular employment sequence. It was intended that the flowchart would provide a measure of employment in terms of time, place, position, and activity. The influence factors part was designed as a list of fifty factors which were selected on the basis of their having been evaluated in several previous studies (Cammack, 1965; Caplow and McGee, 1958; Brown, 1967; and Eckert and Stecklein, 1961) and for their value in measuring the academic phys-

icist's perception of the influence of the economic, educational, familial, and work social systems. The factors were listed so they could be scored on a seven level scale in terms of their importance as an influence in the acceptance of a present job. This scoring was called for in several steps: (1) score (+) if above average influence, (0) if average, and (-) if below average; (2) refine above average scores by marking six factors (++) to designate them as very important influences; (3) refine below average scores by marking six factors (--) to designate them as ones of little importance; (4) choose two factors from the very important designations and mark them (+++) to signify them the most important; (5) choose two factors from the ones of little importance and mark them (---) to signify they were the least important; (6) reexamine all scoring to see if changes need to be made. The intent of multiple pass scoring was to ease the process of evaluating a rather long list of factors. It was assumed that the initial sort into above average, average, and below average scores would result in a symmetric distribution with most in the middle group and roughly equal numbers in the above and below groups. The factors were written in a neutral form to the greatest possible extent and the emphasis in scoring was placed on the importance of factors in influencing job acceptance. Provision was made in the instructions for a factor to be qualified by an appended adjective if, for example, the individual considered a factor important but of a negative character. The sequence in which the factors were listed was determined by a random numbers table.

The questionnaire was distributed to the pilot sample as four separate 8½x11 inch pages stapled in the upper left hand corner. After minor revisions (details of the revisions based on the pilot sample sur-

vey results are given in Chapter V)it was printed on a single 17x11 inch sheet front and back so that, when folded to 8½x11 inches, Part I was the front page; Part II was the inside pages with all segments of the flow-chart in full view, side by side; and Part III was the back page. The ordering of the parts was influenced by a feeling that Part II should be wholly visible as it was filled in and that Part III would be the most troublesome to complete.

Procedures

Pre-testing, the first phase of the survey, was conducted in a conceptual framework with conditions as Backstrom and Hursh have described:

> Pre-testing is the trouble-shooting phase in which you look for the questionnaire's weaknesses. . . . The pre-test is run under actual field conditions. Thirty respondents usually are enough to show the faults in the questionnaire that must be corrected before conducting the study proper. (1963, p. 129)

Questionnaires were mailed to the pilot sample of fifty individuals on 16 March 1968 along with a cover letter which requested comment and criticism on the questionnaire as well as response. A stamped self-addressed envelope was also included and mentioned in the cover letter along with a request for a prompt return. A reminder post card was sent April 7, one week after the suggested return deadline. A preliminary analysis was made of the pilot sample results to determine needed revisions in the main sample questionnaire (Chapter V contains a full presentation of the results).

A revised questionnaire was mailed to the main sample of 800 academic physicists on 16 April 1968. A reminder post card was sent to non-respondents as of May 18 and a second copy of the questionnaire was mailed on June 16. A final follow-up mailing of the questionnaire was

made on 5 October 1968 with consideration that the timing of late spring and summer mailings may have been poor to get a response from physicists who were not teaching at their institutions during the summer. The following chapter is a presentation of the results and analysis--the last phase of the research design.

CHAPTER V

RESULTS AND ANALYSIS

Pilot Sample Results

Results from the pilot sample have been used as an indicator of response rate, a rough measure of main sample characteristics, a first approximation of some parameters to be estimated, and a basis for refining the research questionnaire before it was distributed to the main sample.

Response Rate

A response in some form was received from 88% of the respondents, including late returns, notification of intent not to complete the questionnaire, and word that one respondent had died. Thirty-six of the returned questionnaires (72% of sample) were essentially complete and usable for computing statistics and for analysis. An idea of non-response reasons was given by two respondents who chose not to complete the questionnaire but did write indicating that the information was too personal or that time was not available to assemble the data requested.

Sample Characteristics

Means and standard deviations have been computed for eight characteristics as shown in table 2. Additional non-numerical characteristics were: (1) 97% of the respondents were married, (2) for 89% the doctorate was the highest earned degree, and (3) 60% of those responding had been employed only in academic settings.

TABLE 2

PILOT SAMPLE CHARACTERISTICS

Item	Mean	Standard Deviation
Age	43.3	10.3
Number of children	2.0	1.5
Percent work--research	18.4	19.9
Percent work--teaching	56.2	25.8
Percent work--administration	21.9	25.9
Number of books published	0.4	0.8
Number of articles published	9.1	12.6
Number of employers	2.4	1.4

Characteristics for the pilot sample respondents are similar to comparable characteristics given for physics faculty members in Physics Manpower 1966 (Ellis 1966, pp. 68-69). The order of magnitude of the characteristics has shown that the questionnaire design provided adequate space for the range of personal data variables. One questionnaire refinement, based on a respondent's comment, was the addition of "or adoption" to the personal events item "birth of children".

Influence Factors in Employment

A seven point scale was used to calculate average scores for the "influence factors" part of the questionnaire.* Two factors, "community

*Scale values were assigned: least important = 1, little importance = 2, below average = 3, average = 4, above average = 5, very important = 6, and most important = 7.

industry or business" and "payment of moving costs", were frequently assessed by respondents as least important and had the lowest average scores of 2.62 and 2.88. On this evidence of their minimal significance as an influence in job choice they were deleted from the factors list. Two other factors, "technical services" and "secretarial services", which received low average scores were combined in a single factor for the main sample questionnaire. The parallel factors, "nature of research facilities" and "nature of teaching spaces" proved to be vaguely worded and were rephrased as "physical facilities for research" and "physical facilities for teaching." Along with this rephrasing, the factor "teaching equipment and/or materials" was deleted with the idea that it would be included in "physical facilities for teaching." Other than the evidence of low average scores and notes on individual factors, several comments were made indicating a factor which was important had been omitted from the list. The refinement added to take these concerns into account was an unspecified factor line which was to be completed if the respondent felt a factor of some significance had been omitted. After deletions and modifications, Part III of the questionnaire as distributed to the main sample had forty-six specific factors and one open factor. Several respondents noted that they had been in their job for a number of years and could not assess the factors with any feeling of accuracy. A provision was made in the main sample questionnaire for such individuals to mark an "option" blank and to assess the factors for "importance in the continuance" of their job.

The top few influence factors in order of importance, as determined by mean scores, were: congeniality of colleagues (5.06), emphasis on teaching (5.06), academic freedom (5.00), choice in teaching assignment

(4.94), climate or geography (4.79), faculty administrative relations (4.70), and competency of colleagues (4.70). This selection of factors would suggest that interpersonal factors and teaching aspects are the most significant influences in job acceptance. As a group these factors also support the basic hypothesis in the study by Eckert and Stecklein that job satisfactions tend to center around the nature of the activities performed rather than the external conditions or rewards (1961, p.4).

Notable Relationships

A correlation matrix prepared for the eight characteristics in Table 2 revealed that the number of employers correlated positively with age ($r = 0.564$), percentage of time devoted to teaching ($r = 0.164$), percentage of time devoted to administration ($r = 0.076$), number of books published ($r = 0.074$), and number of articles published ($r = 0.029$). Negative correlations were shown for percentage of time devoted to research ($r = -0.444$) and number of children ($r = -0.251$). The positive correlation with age is not unexpected since an increase in age is a requisite for a new job. Average ages of respondents according to number of employers were: (1) one employer - 37 years, (2) two employers - 40 years, (3) three employers - 48 years, and (4) four employers - 58 years. The correlations of time devoted to teaching, administration, and research with number of employers can be interpreted by noting that in general younger academic physicists devote more time to research while older ones devote more time to teaching and administration (see table 3). The number of publications correlating with the number of employers can be interpreted in terms of a scientific social system in which an exchange process characterizes interaction of the system members (Storer 1966, p. 38). In this case a basic feature, the creative act (p. 57), is expressed

according to the system norms in the form of a product, publication (p. 72), and as an interaction the "commodity" (p. 33) of "professional recognition" (p. 19) is exchanged in the form of a professorship (p. 21). Negative correlation for number of children and employers gives support to the study hypothesis that increasing family responsibilities lead to lower mobility.

TABLE 3

WORK TIME DISTRIBUTION BY PRIMARY FUNCTION

Number of Employers	Research	Teaching	Administration
One	26.8 %	58.2 %	11.8 %
Two	24.0	58.5	16.5
Three	13.7	35.2	48.3
Four or more	2.5	80.3	20.0

Source: Pilot sample data.

Other interesting correlations were shown between books published and articles published ($r = 0.553$), percentage of time devoted to teaching and percentage of time devoted to administration ($r = 0.703$), percentage of time devoted to teaching and percentage of time devoted to research ($r = 0.569$), and age and percentage of time devoted to administration ($r = 0.427$). These correlations suggest a career pattern for academic physicists which starts with an emphasis on research and moves toward administrative duties with age, at the expense of time devoted to teaching and research in that order. The pattern peaks for administrative duties at three employers and is followed by an increase in time devoted to teaching.

Main Sample Results

Results of the study which derive from the main sample have been organized in the following sections with limited commentary of analysis in a sequence from response rate, to sample characteristics, to sample representativeness, to estimated parameters, to data for hypothesis testing, to influence factors in employment, and ending with career patterns.

Response Rate

Oppenheim has made the observation on questionnaire response rates that:

> For respondents who have no special interest in the subject matter of the questionnaire, figures of 40 per cent to 60 per cent are typical; even in studies of interested groups, 80 per cent is seldom exceeded. (1966, p. 34)

For the main sample a return in some form was received from 65% of the respondents and questionnaires were returned by 59%.* All parts of the questionnaire were not completed by each respondent--Part I and Part II were filled in by 56% of the respondents while Part III was marked by only 49%. The response rate compares favorably with the studies by Brown (1967), Marshall (1964), and Gustad (1960). The most direct comparison that can be made is with the study by Parsons and Platt where they reported a response rate from physicists of 53% (1968, p. II-12). This was the lowest rate among disciplines in their sample which included biology, physics, economics, sociology, English and history, and which had an overall rate of 66%. Roe (1953, p. 42) reported that the highest refusal rate in her study was from physicists and attributed this to her

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*Other than returned questionnaires, the responses were notes indicating a reason why the questionnaire would not be completed, letters with data on job mobility rather than the questionnaire, and one indication the questionnaire would be completed if the respondent were compensated for his time to do so.

impression "that physicists have, in actual fact, less time and are under much greater pressure than either of the other groups (biologists and social scientists)." From the non-response reasons elicited by the cover letter for the final questionnaire mailing, it appears that academic physicists are not particularly interested in a study of their job mobility.

Sample Characteristics

Means and standard deviations for some main sample characteristics have been computed and are given in table 4. A comparison of these char-

TABLE 4

CHARACTERISTICS OF ACADEMIC PHYSICISTS

Item	Mean	Standard Deviation
Age	40.1	10.3
Number of children	1.9	1.6
Percent work--research	29.0	23.7
Percent work--teaching	55.8	27.2
Percent work--administration	12.1	18.3
Number of books published	0.4	1.3
Number of articles published	11.8	18.8
Number of jobs	3.5	2.1
Number of employers	2.6	1.7

Note: Characteristics were calculated from the data provided by the 445 individuals who completed Part I of the study questionnaire.

acteristics to the pilot sample suggests that there is bias in the pilot sample results which may be attributed to selection on the basis of per-

sonal acquaintance--the pilot sample had a higher mean age and higher mean of time devoted to administration. Along with a higher percentage of time devoted to research, the main sample is also characterized by a higher publications productivity. Main sample characteristics do not differ so markedly from the pilot sample, but that the comment previously made regarding a favorable comparison to characteristics data from Physics Manpower 1966 (Ellis 1966) is again appropriate.

Other characteristics of the main sample were: (1) marital status--85% married, 12% single, and 3% divorced, separated, or widowed; (2) highest degree-79% doctorate, 18% master's, and 3% bachelor's; (3) articles published per year--one (42%), two (20%), three (14%), four (9%), five (6%), more than five (9%); and (4)papers read per year--one (54%), two (20%), three (10%), four (7%), five (4%), more than five (5%).

A composite description of an "academic physicist" based on the mean characteristics of the study sample shows a person who is 40 years old, is married, has two children, and has a doctoral degree. Having held four jobs with three employers, the academic physicist devotes approximately one-half of working time to teaching, one-third to research. and one-eighth to administration. He publishes one or two articles per year and reads one or two papers per year at professional meetings.

Sample Representativeness

The research design was made so as to have a study sample which was representative of the population of academic physicists in American institutions of higher education offering a physics major. The sampling frame, Directory of Physics & Astronomy Faculties 1967-68, was selected to insure this representativeness. Sampling techniques employed random selection so there would be no bias due to methods of choosing respon-

dents. The evaluation of bias introduced by respondents who chose not to return questionnaires is the remaining factor which must be considered before one can make inferences about the population from the study sample. This non-response bias has been evaluated in terms of age, academic rank and institutional classification for comparable groups of individuals.

Stratification by academic rank was a part of the research design and provides a variable which can be evaluated to determine if returns were properly representative of the population (see table 5). The non-

TABLE 5

ACADEMIC RANK IN POPULATION AND SAMPLE

Academic Rank	Population	Sample
Professor	31.6 %	29.1 %
Associate professor	22.9	22.4
Assistant professor	32.6	36.6
Other	12.7	12.8

response by academic rank has been such as to have professors slightly under-represented and assistant professors slightly over-represented. Assuming professors are older, more likely to have published, and have had more jobs, one could argue that the sample characteristics may be slightly low in value as estimations of the true population parameters.

The variable of age may be used also as an index of representativeness by comparing the sample distribution of ages to two other recent studies--Work Activities and Attitudes of Scientists and Research Managers (Vollmer 1965, p. 24) and American Science Manpower 1966 (NSF 1968,

p. 76) (see table 6). The sample data compare favorably with Vollmer's data from a national sample, but are under-represented in the younger ages by comparison to the NSF report. Two points can be made: (1) if Vollmer's study is the best representation of the population, the sample is a good representation, and (2) if the NSF report is better, the sample would be under-represented for younger ages and the characteristics would be high in value as estimates of the population parameters. Considering the latter case in combination with the previously noted possible effects of under-representation of high academic rank, one could argue that these two aspects tend to cancel. The NSF report is probably biased toward the younger ages by including a 12% component who reported themselves to be either full-time or part-time students (p. 2).

TABLE 6

AGE DISTRIBUTION OF ACADEMIC PHYSICISTS

Age	Sample	Vollmer's Study	NSF Study
Under 30	11 %	12 %	35 %
30 to 39	48	50	35
40 to 49	24	27	18
50 to 59	12	11[a]	8
60 and over	5		4

Note: [a]Vollmer reported older ages only as 50 and over.

As a final indicator of representativeness one can examine the returns of questionnaires by the classification of respondent's institutions according to the highest level of degree offered. After the study sample of 800 was selected, the respondent's institutions were

identified according to the highest degree offered using the Education Directory: 1966-1967 (1967, p. 1) classifications: Class II--only bachelor's and/or first professional degree; Class III--Master's and/or second professional degree; and Class IV--Doctor of Philosophy and equivalent degree. The percentage of respondents at each class of institution and the percentage of respondents returning questionnaires from each class was found to be in close agreement (see table 7). Thus, one can assume

TABLE 7

COMPOSITION BY INSTITUTIONAL CLASS FOR SAMPLE AND RETURNS

Class	Sample	Returns
II	15 %	17 %
III	26	25
IV	59	58

that there is no non-response bias according to institutional classification by highest level of degree offered.

The representativeness of the study sample, as indicated by comparison to other studies and known parameters, in terms of academic rank, age, and institutional classification, seems to be adequate for drawing inferences about the study population.

Estimated Parameters

Statistics have been computed for most of the variables measured by the study questionnaire and for some combinations of variables to get estimated parameters which would characterize the population of academic

physicists in terms of their mobility.* Mobility has been assessed in terms of the number of jobs (NOJ) and the number of employers (NOE) in order to highlight job mobility (which counts separately each change of title or activity with the same employer) and to get an idea of geographical mobility. Other than the basic statistical measures of means, standard deviations, and correlation coefficients, three measures which have been used are the Pearson chi-square test for association, Cramer's statistic (CS) as a measure of the strength of association, and an index of predictive association (IPA) that will give a measure of the extent mobility may be predicted if one is given information on other variables. Chi-square values have been evaluated from tables (Hays 1963, pp. 675-76) for a given level of confidence, while CS and IPA have been evaluated in a range of values from zero to one which indicates respectively complete independence to complete dependence and no predictability to complete predictive association. (See Appendix III for further details on these statistical measures.)

Mobility and age--a cultural dimension

In the background of the several characteristics which have been used to describe academic physicists there is the cultural influence of discrimination according to age. Slocum has pointed out that:

> Those who have reached this age [50] have relatively few opportunities to move to permanent positions in other universities unless they have achieved outstanding reputations in their fields; even these move much less frequently after age 50 than when they are younger. Slowing down of mobility with advancing age is de-

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* Statistics have been produced with the computer programs PSCF: BLITZ--Bivariate Frequency & Percentage Tables, & Statistics and STAT: BMD03D--Correlation with Item Deletion which are available at the University of Michigan Computing Center.

> termined to a large extent by the culture. . . . There is widespread discrimination against employment of older men in all occupations. Furthermore, older men are more likely to have established community ties that tend to discourage migration. (1966, p. 250)

Although there is a slowing of mobility with age, one expects to find that the number of employers and jobs held increases with age. Study results bear out the observations made above with a correlation between age and NOJ ($r = 0.563$) and between age and NOE ($r = 0.436$) (see table 8 for NOJ

TABLE 8

MOBILITY AND AGE

Age Group	Mobility			
	Number of Employers		Number of Jobs	
	Mean	s.d.	Mean	s.d.
Under 30 (46)	1.54	0.69	1.67	0.76
30 to 39 (207)	2.18	1.13	2.85	1.46
40 to 49 (103)	2.95	1.55	4.17	1.79
50 to 59 (51)	3.46	1.70	5.04	2.14
60 and over (26)	3.81	1.98	5.58	2.27

Notes: Numbers in parentheses are the count of respondents in each class.

Differences in means in increasing order of age groups are 0.64, 0.77, 0.51, and 0.35 for NOE and 1.18, 1.32, 0.87, and 0.54 for NOJ.

Chi-square is significant beyond 0.001 level for both NOE and NOJ.

Cramer's statistic for age and number of employers (CS:NOE) is 0.250 and for age and number of jobs (CS:NOJ) is 0.342.

Indexes of predictive association are (1) 0.040 for predicting NOE given age (IPA:AGE--NOE) and (2) 0.066 for predicting NOJ given age (IPA:AGE--NOJ).

and NOE according to age). From table 8 one can see that mobility slows with age by noting the differences between means for the sequence of age groups. The statistically significant relationship between age and mobility (chi-square beyond 0.001 level) has a modest strength of association (CS:NOJ = 0.342 and CS:NOE = 0.250) and a low index of predictability (IPA:AGE--NOJ = 0.066 and IPA:AGE--NOE = 0.040).

Mobility and the family social system

Considering the family social system to be one in which the academic physicist gains important identifying characteristics, the variables of marital status and number of children have been measured. In noting the significance of the family Taylor has written:

> Family life has been historically more determinant on occupations than occupations on family life. . . . Family organization continues to provide many formal and informal mechanisms for occupational values and ideologies. (1968, p. 472)

Considering family influences on mobility as basically a matter of stabilization stemming from family system values of order, protection, and stability, one would expect a relationship to exist especially between family characteristics and NOE. The expected relationship would be one which shows decreasing mobility with increasing family responsibility as measured first by marriage and secondarily by the number of children.

Survey results which measured marital status as single, married, and other (divorced, separated, or widowed) do not show a statistically significant relationship for NOE or NOJ (see table 9). A slight strength of association is indicated by Cramer's statistic but there is no indication of predictive association. The hint of association might be interpreted as greater mobility for single persons and highest mobility for those divorced or separated due to the disruptive character of that status, but no meaningful analysis can be made due to the small number of

respondents involved.

TABLE 9

MOBILITY AND MARITAL STATUS

Marital Status		Mobility			
		Number of Employers		Number of Jobs	
		Mean	s.d.	Mean	s.d.
Single	(53)	2.60	1.64	3.40	2.07
Married	(370)	2.51	1.45	3.43	1.94
Other	(12)	2.92	1.78	4.25	2.26

Notes: CS:NOE = 0.117; CS:NOJ = 0.114.
IPA:MARITAL STATUS--NOE and IPA:MARITAL STATUS--NOJ equal zero.

Findings of the pilot sample indicated a negative correlation for number of children and number of employers in keeping with the expectation of an effect on mobility, but this correlation has been reversed in the main sample results to show a small positive correlation both for NOE ($r = 0.098$) and NOJ ($r = 0.162$) (see table 10). Cramer's statistic shows a slight strength of association, and predictive indices have small positive values for number of children in relation to mobility. Survey results lead to the rejection of the hypothesis that mobility will decrease with an increase in family responsibility and suggest that a converse hypothesis of mobility increasing with increasing family responsibilities could be examined. With no statistical significance at an acceptable level (0.05 or less) one is led to conclude that number of children as well as marital status have no marked influence on mobility.

TABLE 10

MOBILITY AND NUMBER OF CHILDREN

Number of Children		Mobility			
		Number of Employers		Number of Jobs	
		Mean	s.d.	Mean	s.d.
None	(108)	2.37	1.46	3.05	1.86
One	(64)	2.42	1.47	3.27	2.03
Two	(123)	2.67	1.49	3.42	1.89
Three	(82)	2.50	1.49	3.77	2.02
Four	(36)	2.81	1.53	4.14	1.96
Five	(7)	2.14	1.35	3.71	2.14
Six or more	(15)	2.80	1.57	3.67	2.26

Notes: CS:NOE = 0.117; CS:NOJ = 0.148.

IPA:CHILDREN--NOE = 0.029; IPA:CHILDREN--NOJ = 0.038.

Mobility and the work social system

Several variables have been measured which characterize the academic physicist in the work social system--academic rank, work activity, and productivity. Academic rank has been assessed in terms of the hierarchial classification which ranges from professor, to associate profe-sor, to assistant professor, to instructor. The percentage of working time currently devoted to the functions of teaching, research, and administration have been used to assess work activity. Productivity has been measured in terms of books and articles published and papers read at professional meetings.

Academic rank as a hierarchy of positions in the work social system would be expected to correlate with mobility (see table 11). The stronger relationship between academic rank and the number of jobs held is indicative of a pattern where an individual remains at a given institution and progresses in jobs from lower to higher academic rank.

If one assumes that an individual seeks to find a position in which he may divide his energies among the several work functions as he

TABLE 11

MOBILITY AND ACADEMIC RANK

Academic Rank		Mobility			
		Number of Employers		Number of Jobs	
		Mean	s.d.	Mean	s.d.
Professor	(127)	3.00	1.55	4.81	1.95
Associate Professor	(98)	2.70	1.54	3.58	1.84
Assistant Professor	(155)	2.23	1.26	2.58	1.37
Other	(56)	2.04	1.46	2.50	1.80

Notes: Chi-square is significant at the 0.01 level for both NOE and NOJ.

CS:NOE = 0.188; CS:NOJ = 0.321.

IPA:ACADEMIC RANK--NOE = 0.082; IPA:ACADEMIC RANK--NOJ = 0.228.

finds most satisfying, a measure of time devoted to research, teaching, and administration is likely to show a relationship to mobility. This assumption does not imply that individuals devoting a greater proportion of their time to a given function will be more mobile, but that according to the dynamics and values of the work system they will be either

more or less mobile than others. Using the concept of a scientific social system as an "exchange model" in which publications are exchanged for the "commodity" of academic positions, one might expect academic physicists to seek out positions where they can devote a maximum amount of time to research and its associated publication activities. By this line of reasoning, academic physicists who devote most of their time to research would be expected to have been more mobile. Those who devote most of their time to teaching would be expected to have been least mobile, and those who devote most of their time to administration might be expected to have been more mobile in a quest for the limited number of administrative positions which are valued in the work system (see tables 12, 13, and 14).

Contrary to expectations the relationship between percentage of time devoted to research and mobility is not statistically significant. In fact the correlation between the variables is slightly negative for both number of employers ($r = -0.126$) and number of jobs ($r = -0.109$). The strength of the association is slight and the predictability is essentially zero. One interpretation that could be made of the evidence that persons devoting more time to research are less mobile is that once one has gained a position where a significant proportion of time can be devoted to research there is little incentive to seek another position.

As expected, a relationship was shown between percentage of time devoted to teaching and mobility, but interestingly a statistically significant association was present only for number of jobs as a measure of mobility. Negative correlations exist for both number of jobs ($r = -0.156$) and for number of employers ($r = -0.025$), strengths of association as indicated by Cramer's statistics are slight, and indices of predictive association are small. The difference in statistical significance be-

TABLE 12

MOBILITY AND RESEARCH ACTIVITY

Percent of work time devoted to research	Mobility			
	Number of Employers		Number of Jobs	
	Mean	s.d.	Mean	s.d.
Under 10 (109)	2.84	1.72	3.61	2.24
10 to 19 (49)	2.67	1.85	3.57	2.25
20 to 29 (62)	2.48	1.49	3.60	2.08
30 to 39 (41)	2.51	1.31	3.71	1.91
40 to 49 (53)	2.32	1.28	3.36	1.73
50 to 59 (68)	2.26	1.13	3.13	1.64
60 to 69 (24)	2.37	1.28	3.16	1.84
70 to 79 (17)	2.47	1.07	3.12	1.32
80 to 89 (7)	1.86	0.90	2.71	1.70
90 to 99 (3)	3.33	1.53	3.67	1.15
100 (2)	2.50	0.71	3.00	1.41

Notes: CS:NOE = 0.150; CS:NOJ = 0.130
IPA:RESEARCH--NOE = 0.003; IPA:RESEARCH--NOJ = 0.006

tween NOE and NOJ can be interpreted as a pattern of an individual staying at a given institution but not moving up in jobs as rapidly as the individual who devotes less time to teaching and presumably more to research.

The expected greater mobility for individuals who devote a greater amount of time to administration has been supported by study results to an unexpected degree of association. Values for Cramer's statistic indicate a strength of association which has been exceeded among all study results only by age and academic rank in relation to mobility. With chi-square actually significant beyond the 0.001 level for both NOE and NOJ, one can say with little probability of refutation that academic

TABLE 13

MOBILITY AND TEACHING ACTIVITY

Percent of work time devoted to teaching		Mobility			
		Number of Employers		Number of Jobs	
		Mean	s.d.	Mean	s.d.
Under 10	(12)	3.33	1.61	4.00	2.59
10 to 19	(16)	2.81	1.28	4.37	1.41
20 to 29	(42)	2.69	1.49	3.93	2.15
30 to 39	(42)	2.52	1.09	3.95	1.60
40 to 49	(56)	2.45	1.40	3.32	1.94
50 to 59	(71)	2.30	1.18	3.32	1.73
60 to 69	(39)	2.79	1.73	3.90	2.26
70 to 79	(41)	2.05	1.48	2.73	1.94
80 to 89	(36)	2.67	1.60	3.33	1.90
90 to 99	(37)	2.59	1.86	2.95	2.07
100	(43)	2.63	1.60	3.12	1.94

Notes: Chi-square is significant at the 0.05 level for NOJ.

CS:NOE = 0.166; CS:NOJ = 0.178.

IPA:TEACHING--NOE = 0.019; IPA:TEACHING--NOJ = 0.033.

physicists who devote significant portions of their time to administration have been highly mobile individuals. Interestingly though, along with the notable significance and strength of association, indices of predictive association are essentially zero and correlation coefficients do not have large values ($r = 0.372$ for NOJ; $r = 0.185$ for NOE). The low values of IPA can be explained by examining the distribution of respondents according to time devoted to administration: 57% of respondents devote less than 10% of their time to administration and only 7% devote 50% or more.

TABLE 14

MOBILITY AND ADMINISTRATIVE ACTIVITY

Percent of work time devoted to administration		Mobility			
		Number of Employers		Number of Jobs	
		Mean	s.d.	Mean	s.d.
Under 10	(248)	2.35	1.37	2.94	1.70
10 to 19	(72)	2.39	1.36	3.34	1.79
20 to 29	(40)	2.75	1.75	3.87	2.17
30 to 39	(30)	2.70	1.37	4.13	1.66
40 to 49	(15)	3.73	1.94	5.73	2.49
50 to 59	(11)	4.18	1.33	6.18	1.99
60 to 69	(11)	3.09	1.64	5.00	1.48
70 to 79	(2)	1.00	----	4.50	0.71
80 to 89	(4)	2.50	1.00	4.50	2.08
90 to 99	(1)	4.00	----	4.00	----
100	(1)	5.00	----	9.00	----

Notes: Chi-square is significant beyond 0.001 level for both NOE and NOJ.

CS:NOE = 0.214; CS:NOJ = 0.240.

IPA:ADMINISTER--NOE = zero; IPA:ADMINISTER--NOJ = 0.005.

Previous discussions have pointed to publications productivity as an important variable in the work social system which should be related to mobility. This variable has been assessed in terms of the total number of books and articles published in terms of the rate of publica-

tion of articles and presentation of papers at professional meetings. The latter factors have been included to give some weight to the effect of young men who may be very productive but who have not as yet amassed a large total of publications. In constructing a productivity index, which will be discussed later, additional consideration has been given to professional productivity such as national organization committee work, government service as a consultant, and research administration.

Book publication is viewed as a major contribution in the work system which brings prestige and attention to the author. Following the "exchange model" concept, one would expect greater job mobility for the academic physicists who publish larger numbers of books (see table 15).

TABLE 15

MOBILITY AND BOOKS PUBLISHED

Number of books published		Mobility			
		Number of Employers		Number of Jobs	
		Mean	s.d.	Mean	s.d.
None	(360)	2.42	1.39	3.23	1.85
One	(45)	2.69	1.77	4.18	2.32
Two	(13)	3.92	1.98	5.46	2.37
Three	(8)	2.75	1.04	4.25	1.58
Four or more	(10)	3.90	1.29	4.60	1.35

Notes: Chi-square is significant beyond 0.001 level for both NOE and NOJ.
CS:NOE = 0.210; CS:NOJ = 0.200.
IPA:BOOKS--NOE and IPA:BOOKS--NOJ are zero.

Survey results on books and mobility are similar to those on administration and mobility--statistically significant with a modest strength of association but no predictive association. The small number who have written one or more books, only 76 of the respondents, prevents more extensive analysis with inferences about the population. From the survey evidence one can say that there is little likelihood of error in an assertion that academic physicists who publish books are more mobile than those who do not publish books.

Along with books, published articles constitute a product for exchange in the work social system. Since the number of articles published by the respondents ranged from zero to 160, an interval scale has been employed to provide a more manageable measure. Intervals chosen for the scale have been selected so as to divide the sample into ten approximately equal parts (see table 16). An examination of the results would be

TABLE 16

PUBLISHED ARTICLES INTERVAL SCALE

Articles Published	Scale Number
0	0
1	1
2	2
3-4	3
5-7	4
8-12	5
13-19	6
20-30	7
31-59	8
60 plus	9

expected to show that the more mobile individuals are the publishers of larger numbers of articles (see table 17). The differentiation made

TABLE 17

MOBILITY AND ARTICLES PUBLISHED

Article interval scale number		Mobility			
		Number of Employers		Number of Jobs	
		Mean	s.d.	Mean	s.d.
0	(82)	2.71	1.60	3.20	1.88
1	(45)	2.20	1.60	2.84	2.14
2	(44)	2.07	1.30	2.73	1.56
3	(47)	2.36	1.63	3.11	2.16
4	(48)	2.29	1.44	3.04	2.00
5	(49)	2.61	1.38	3.39	1.69
6	(40)	2.72	1.36	4.22	1.82
7	(43)	2.93	1.22	4.21	1.61
8	(19)	3.21	1.51	4.58	1.74
9	(18)	2.50	1.34	5.11	2.00

Notes: Chi-square is significant beyond 0.001 for NOJ.
CS:NOE = 0.163; CS:NOJ = 0.197.
IPA:ARTICLES--NOE = 0.006; IPA:ARTICLES--NOJ = 0.020.

between NOE and NOJ is dramatically illustrated by the statistical relationships found between mobility and number of articles published. The number of articles and the number of jobs held is significant beyond the 0.001 level while the number of employers does not show significance until 0.08 level is reached. When one considers that the major component of the difference between NOE and NOJ is advancement in academic rank, this result suggests that publication is more important to advancement at a

given institution than it is to movement among institutions. Strengths of association and indices of predictability show similar ranges of values and orders of magnitude as for mobility and books.

Without detailing them in a tabular presentation, the results of statistical analysis on number of articles per year and number of papers read per year at professional meetings can be summarized by noting that articles per year show results similar to the total number of articles published and papers per year show no significant relationship to mobility (see appendix III for tables giving full data on these results).

Mobility and the educational social system

The central characteristic which derives from the educational social system and which would seem most probable to influence the mobility of an academic physicist is that of the highest degree earned. Two lines of reasoning may be followed to set expectations for the mobility being increased or decreased as the earned degree level is raised. The first line of reasoning which leads to an expectation of decreased mobility may be found in Occupational Mobility of Scientists (U.S. Bureau of Labor Statistics 1953, p. 2), and it is basically an argument that a greater amount of education leads to a specilization of abilities such that mobility is limited by the small number of work opportunities open for any highly specialized activity. But within this argument one finds the seeds of an opposite line of reasoning as the following quotation from the study shows: "Implicit in a doctor's degree is a mastery of techniques and a body of knowledge, which acts as a barrier to movement between scientific fields, but which facilitates shifts among different kinds of work within a particular area of specialization" (p. 3). Super presents the reasoning for increased mobility in the following manner:

> But in the case of the professions and certain technical occupations and trades, education is the immediate means of occupational mobility. Entry can be obtained only through formal education. When obtaining the formal education is made difficult, this avenue of upward mobility is virtually closed; when obtaining education is made easy, upward mobility is facilitated. (1957, p. 28)

Although both lines of reasoning appear to be applicable to the profession of academic physicists, the second seems more likely to be the dominant effect--increased mobility as a result of a higher degree (see table 18).

TABLE 18

MOBILITY AND HIGHEST DEGREE

Highest Degree		Mobility			
		Number of Employers		Number of Jobs	
		Mean	s.d.	Mean	s.d.
Bachelors	(11)	2.27	1.10	2.45	1.29
Masters	(79)	2.72	1.72	3.25	2.09
Doctors	(343)	2.50	1.43	3.52	1.95

Notes: CS:NOE = 0.093; CS:NOJ = 0.114.

IPA:DEGREE--NOE and IPA:DEGREE--NOJ are both zero.

Survey results fail to support either line of reasoning at a level of acceptable statistical significance. The only hint of statistical support to be found is in a strength of association for NOJ and highest degree with this relation going toward increased mobility.

Data for Hypothesis Testing

Several hypotheses were stated in Chapter III (pp. 48-49) for which survey results provide a basis for testing. Some of the results

given in the previous section on estimated parameters provide the evidence for acceptance or rejection, while other results require additional information related to the prestige of institutions, a factor not measured by the survey questionnaire.

The estimated parameter data given in table 18 showed no chi-square significance at an acceptable level (0.05 or beyond) to support the hypothesis that mobility increases as the level of higher education degree attainment increases, therefore this hypothesis is rejected.

Estimated parameter data in tables 9 and 10 respectively showed no chi-square significance for marital status or number of children to support the hypothesis that mobility decreases as an individual's family responsibilities increase, therefore this hypothesis is rejected.

Table 8 data on age and mobility can be evaluated to show that there is evidence to accept the hypothesis that mobility decreases with age. One may first note that the relationship between age and mobility is statistically significant by chi-square test for association beyond the 0.001 level of confidence, then examination of the differences in means for the age groups shows the declining rate of mobility (see figure 3).

The hypothesis that mobility decreases after a tenured position has been achieved has been tested by tabulating the number of employers before and after tenure for the 172 respondents who reported they had achieved a tenured position (see table 19). The difference between the mean number of employers before and after tenure is significant at the 0.05 level by a t-ratio test (Hays 1963, p. 317). To insure that this difference was not just a measure of the asymmetric occurence of tenure in a career span, the average number of years per employer was calculated

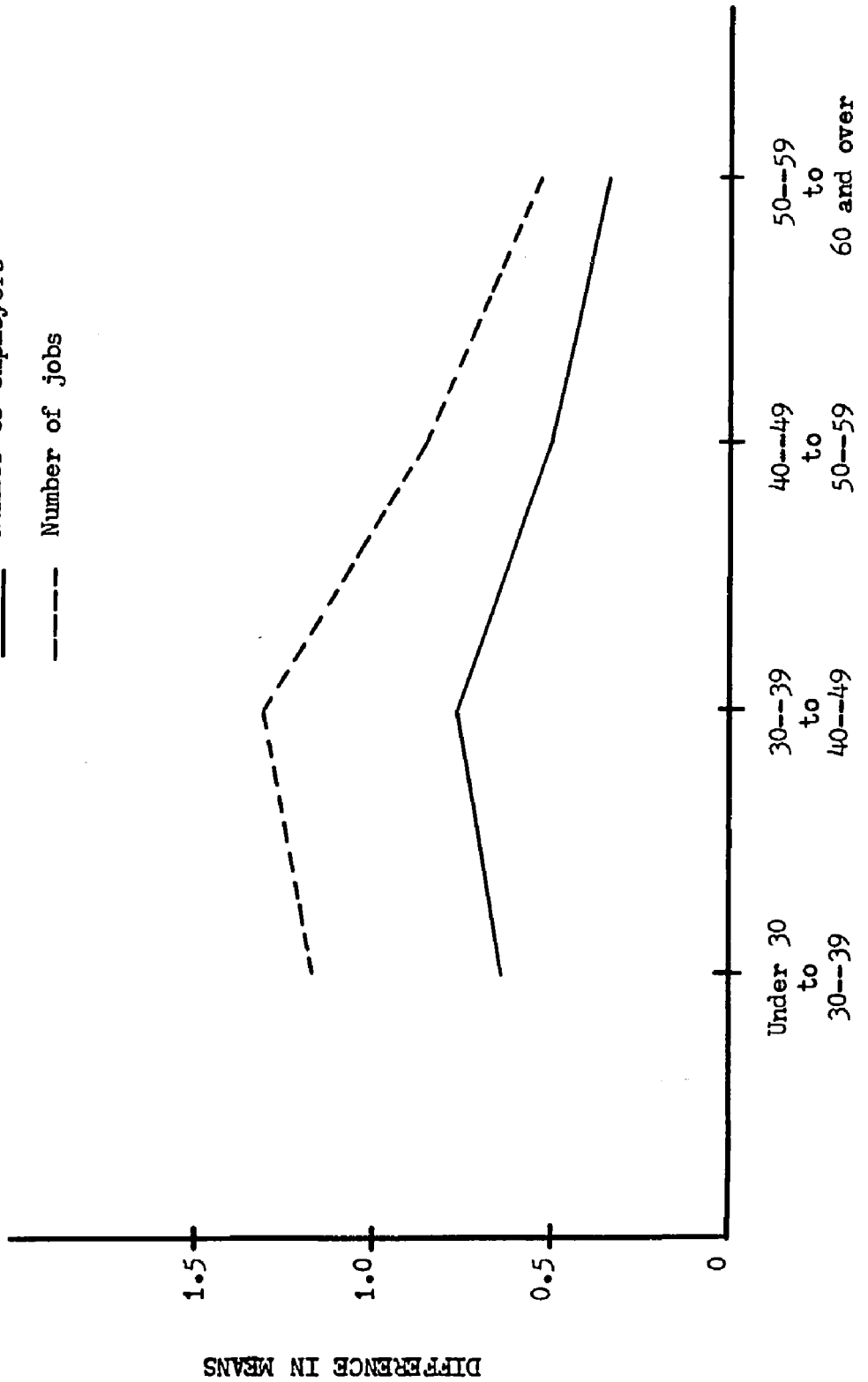


Fig. 3--Difference in Mobility Means by Age Groups

TABLE 19

MOBILITY AND TENURE

Item	Mean	s.d.
Employers before tenure	2.06	1.40
Employers after tenure	1.19	0.62
Years per employer before tenure	4.07	2.46
Years per employer after tenure	8.18	7.64

for before and after tenure, and this data showed a decidedly greater value for years per employer after tenure (see table 19). Evidence as shown by the number of employers and the number of years per employer before and after tenure seems sufficient to support acceptance of the hypothesis.

The other hypotheses set forth in Chapter III have been stated in terms of the prestige of institutions where the academic physicist either worked or received his highest degree. An index for assessing institutional prestige has been devised for use in testing these hypotheses. This index combines nine numerical data factors representing the components of faculty, students, library, and financial resources in a prestige assessment which permits institutional comparison (see appendix IV). An index for professional productivity has also been constructed from the data reported for books and articles published, articles and papers produced per year, and other professional productivity (see appendix V).

Data for testing the hypothesis that interprestige movements in

mobility are downward in the prestige hierarchy were assembled by computing prestige index values for the institutions where the respondents have been employed during the period 1958 to 1968 and then recording whether their changes of employment (118 cases) led to a higher or lower prestige institution (see table 20). The significantly larger percentage of downward changes provides evidence for accepting the hypothesis of downward prestige mobility as the more common event in employer changes.

TABLE 20

MOBILITY AND CHANGE IN INSTITUTIONAL PRESTIGE

Direction of Prestige Change	Percentage of Employer Changes
Upward	32 %
Downward	63
No change	5

Evaluation of the interrelationship between productivity, the prestige of the degree awarding institution, and the direction of inter-prestige mobility has been made by tabulating these variables in broad classifications above mean (AM) and below mean (BM) and according to level of productivity or direction of prestige change (see tables 21 and 22).

The data in table 21 do not support the hypothesis that productivity above the mean correlates with stable or upward prestige movement, but suggest instead that similar proportions by productivity are to be found in each class of respondents according to direction of prestige change. Similar results are found for movements which do not include the degree granting institution as the first prestige identification (in table 20, for example, only 8% of the cases classified as upward or no change for prestige direction fall into the high productivity category). The evidence in table 22 adds further weight to rejection of the hypothesis by

TABLE 21

PRESTIGE CHANGE--DEGREE INSTITUTION TO EMPLOYER

Direction of Prestige Change	Percent of Total	Cases			
		AM Productivity		BM Productivity	
		Number	Percent	Number	Percent
Upward (46)	13.4	15	32.6	31	67.4
Downward (247)	71.8	81	32.8	166	67.2
No change (51)	14.8	16	31.4	35	68.6

Note: AM = above mean; BM = below mean.

TABLE 22

PRODUCTIVITY, DEGREE INSTITUTION, AND EMPLOYER

Degree Institution and Employer Classification	Productivity Level		
	High	Medium	Low
AM:AM (161)	47 cases	71 cases	43 cases
AM:BM (130)	10	34	86
BM:AM (7)	2	2	3
BM:BM (50)	2	9	39

Note: The notation AM:AM indicates that the degree awarding institution and the present employing institution both had prestige rankings above the mean; BM:AM designates a below mean degree institution and an above mean employing institution; etc.

showing that as many cases of low productivity coincide with AM:AM as do

high productivity and that high productivity in other "degree institution-employer" classifications are not significantly related. The data of table 22 support the acceptance of the hypothesis that the prestige of the institution where an individual receives his degree correlates with the prestige of his employing institution even when the effects of his productivity are considered. The sense of this correlation is that it is most likely that an individual receiving a degree from an AM prestige institution will be employed by an AM prestige institution whether his productivity is high or low. Secondarily, an individual with a degree from an AM prestige institution is likely to be employed at an institution with BM prestige and be characterized by medium or low productivity. (It is interesting to conjecture whether evidence of low productivity leads to low prestige employment or whether the necessity of the work system pattern of downward prestige mobility places the individual in a position where he is unable to be as productive.) Finally, the sense of correlation is that an individual who receives his degree from a BM prestige institution is likely to be employed by an institution with BM prestige. The least likely event is the case of an individual with a degree from a BM prestige institution being employed at an AM prestige institution.

Influence Factors in Employment

The forty-six influence factors which were assessed in the study questionnaire have been analyzed in three ways: (1) a frequency distribution for each factor with classifications from least important to most important, (2) a mean value for each factor calculated by assigning the numbers one to seven to the classifications respectively from least important to most important, and (3) computation of mean values for groups

of related factors.

Frequency distributions may be used to evaluate the significance of individual factors according to the criterion that large numbers of cases above or below the mid-point on the importance scale indicate the most and least important factors (see appendix VI). Mean values for each factor along with its rank in the whole list of factors are given by groupings in table 23. Means have been calculated for groups of individual factors to get an idea of the more significant spheres of influence in the acceptance or continuance of employment (see table 24). The results summarized in tables 23 and 24 show the most influential spheres to be the persons and activities which might be called the "inner" core of the work social system, and the results show the least influential spheres to be the "outer" or support aspects of the system.

An analysis of the results of the measurement of influence factors can be made by comparing the results to the top-ranked findings of Cammack (1965, p. 67) and Brown (1967, p. 154). Cammack's factors were ranked in terms of their importance in the selection of an academic position by a group of faculty members from several disciplines, while Brown's were detailed according to discipline (the ones listed are for physics) (see table 25). By comparing the top ten factors in each study one can find a general pattern which moves down in importance from colleagues, to academic freedom, to research, to teaching, and ends with salary. Compared to all disciplines, it appears that physicists place less importance on the library. Brown's study which considered only newly hired faculty members appears to be biased toward research importance. Survey data of the present study which covered a broader spectrum of faculty members introduces factors such as institutional size and geographical

TABLE 23

INFLUENCE FACTORS IN EMPLOYMENT

Group	Rank	Mean
Personal		
Congeniality of colleagues	1	4.85
Competency of colleagues	3	4.69
Faculty-chairman relationship	11	4.37
Personal or family preference	18	4.25
Nearness to friends or relatives	33	3.52
Research		
Time for research	4	4.59
Research funds or opportunities	9	4.40
Physical facilities for research	19	4.22
Emphasis on research	25	4.12
Research assistants	41	3.39
Teaching		
Emphasis on teaching	6	4.48
Choice in teaching assignment	8	4.44
Level of teaching assignment	15	4.29
Contact hours of teaching	16	4.28
Physical facilities for teaching	28	3.93
Teaching assistants	42	3.29

(continued next page)

TABLE 23--continued.

Group	Rank	Mean
Prestige		
Academic rank	21	4.16
Prestige of department	23	4.14
Prestige of institution	26	4.09
Reputation of a faculty member	32	3.56
Community		
Climate or geography	10	4.38
Cultural aspects of community	24	4.13
Educational aspects of community	27	4.03
Recreational aspects of community	29	3.86
Cost of living in community	34	3.50
Institutional		
Size of institution	5	4.52
Advancement prospects	12	4.34
Quality of students	14	4.32
Library holdings and services	31	3.73
Secretarial-technical aides	37	3.44
Office space	39	3.42
Commuting and/or parking	40	3.40

(continued next page)

TABLE 23--continued.

Group	Rank	Mean
Administrative		
Academic freedom	2	4.80
Faculty-administrative relations	20	4.18
Promotion and tenure policies	22	4.15
Faculty role in policy making	30	3.77
Retirement plan	38	3.43
Non-financial fringe benefits	43	3.26
Committee or extra activities	45	2.91
Economic		
Salary	7	4.47
Future salary prospects	13	4.33
Expenses paid to meetings	35	3.46
Financial fringe benefits	36	3.45
Financial aid for publication	44	3.09
Consulting-extra income prospects	46	2.89

location into the list of high importance items.

Career Patterns

From the data provided in the educational-employment flowchart part of the study questionnaire, career patterns in employment have been tabulated in terms of academic, non-academic, and other employment. This tabulation has not included jobs which were for time periods less than a year in length, jobs which were held concurrently (secondary

TABLE 24

RANK OF INFLUENCE FACTOR GROUPS

Group	Rank	Mean
Personal	1	4.32
Research	2	4.15
Teaching	3	4.12
Prestige	4	3.99
Community	5	3.98
Institutional	6	3.88
Administrative	7	3.79
Economic	8	3.62

activities), or military service. One sub-categorization, which appeared with notable frequency in the academic only pattern, was an eight percentage component of individuals whose pattern was secondary school to higher education employment (see table 26). The percentages associated with each pattern show a surprising similarity to the results Ginzberg (1966, p.61) reported for a follow-up study of a sample of 342 male graduate fellowship holders at Columbia University. He found (1) 58% had a straight pattern, (2) 29% had a broad pattern, and (3) 13% had a variant pattern.

Analysis

One way of analyzing the mobility of academic physicists is to compare findings from this study with findings from the study done by Lansing and Mueller for a national sample of all workers. They have made the general observation that:

> One of the basic characteristics of the population of the United States is its geographic mobility. In the course of their life-

TABLE 25

COMPARISON OF JOB CHOICE INFLUENCES

Rank	Factors		
	Survey Data	Brown's Study	Cammack's Study
1	Congeniality of colleagues	Research facilities	Department chairman relationship
2	Academic freedom	Colleague competency	Calibre of associates
3	Competency of colleagues	Teaching load	Academic freedom
4	Time for research	Courses taught	The library
5	Size of institution	Near graduate school	Teaching load
6	Emphasis on teaching	Reputation of school	Reputation of the department
7	Salary	Congeniality of colleagues	Salary
8	Choice in teaching assignment	Quality of students	Income potential
9	Research funds or opportunities	Academic rank	Time for research
10	Climate or geography	Salary	Choice in teaching assignment

> time most people move from one area to another. At the present time two heads of families out of three are living in a different area from that in which they were born. Even among the remaining one third, some have lived elsewhere and returned to their place of birth. (1967, p. 3)

Lansing and Mueller reported a mean number of moves as 2.2, which in comparison to the present study's mean number of employers of 2.6, suggests that academic physicists are slightly more mobile than the population in general (see table 27 for a rough comparison of movers). They found that mobility was a function of age with a pattern similar to that reported in this study, but the peak of mobility occurred at an earlier age (see figure 4 and compare it to figure 3). Their findings on mobility as a function of education showed a strength of relationship which the present study has not demonstrated within the domain of higher education degrees (see table 28).

TABLE 26

CAREER PATTERNS

Pattern	Percentage
Academic employment only	60
Non-academic to academic employment	22
Other and combination	
Secondary school to higher education	8
Academic to non-academic to academic	5
Miscellaneous others	5

A lack of statistical significance in the relationship of mobility to the family system is in keeping with Eiduson's (1962) study of scientists from a psychological frame of reference. With particular pertin-

TABLE 27

MOBILITY COMPARISON--ACADEMIC PHYSICISTS TO U. S. POPULATION

Academic Physicists[a]		Heads of Families[b]	
Number of Employers	Percent[c]	Number of Moves	Percent[c]
1	29	0	71
2	29	1	13
3	20	2	8
4	11	3	4
5	6	4	2
6	3	5	1
7 or more	1	6 or more	1

Notes: [a]Study data.

[b]Data from Geographic Mobility of Labor by Lansing and Mueller (1967, pp. 29-30).

[c]Percentages do not add to 100% due to rounding.

ence for the findings on the family she has observed that:

> The biographical information shows that, in general, adult relationships have been stable.... They demand much less support from relationships outside of work, and much less of their sense of personal identity comes from their other roles. I was struck, for example, by the fact that the family problems, and even some severe psychological disorders in children and wives, arouse relatively little conflict in these scientists as husbands and fathers--not comparable to the degree that work problems arouse. (1962, p. 95)

The remote relation of family concerns to prestige maximization may be a fundamental reason no statistical association has been demonstrated

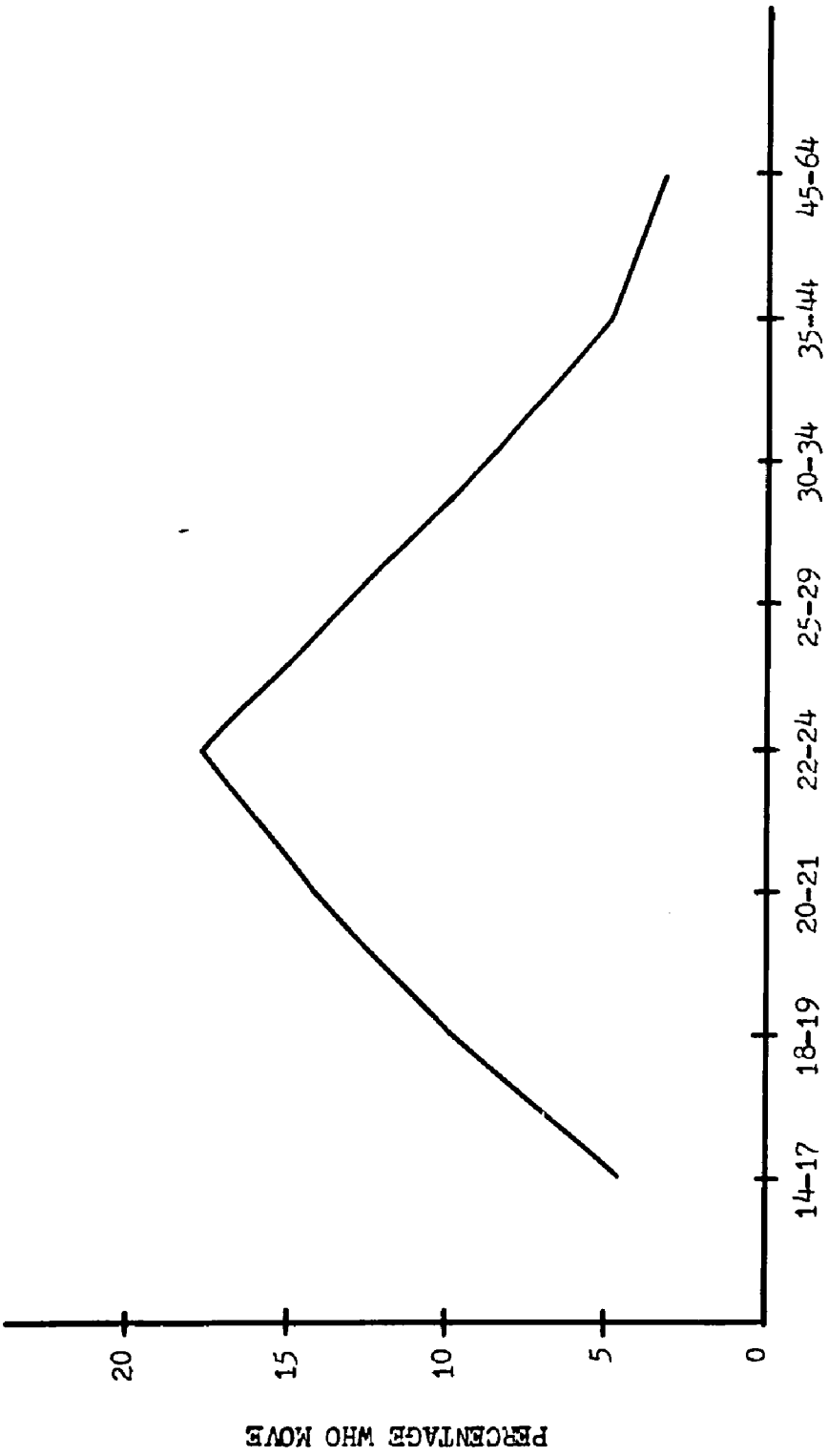


Fig. 4--Geographical Mobility and Age Group

Data from Lansing and Mueller (1967, pp. 39-40).

for the variables of the family system and mobility.

TABLE 28

MOBILITY AS A FUNCTION OF EDUCATION

Educational Level	Percentage of adult males aged 25 or over who migrated in 1964-65
Elementary (0-8 years)	4.0
High school (1-3 years)	4.8
(4 years)	6.0
College (1 year or more)	8.8

Note: Data are from Geographical Mobility of Labor by Lansing and Mueller (1967, p. 43).

The lack of statistical significance in the relationship of mobility and the educational system variable of highest degree may also be fundamentally a reflection of the nature of the prestige mechanism and its predominant effect--downward prestige movement from highest degree institution to employment. Prestige maximization for the doctorate holder who must necessarily move downward for his first employment is perhaps a matter of staying with that employer since the mechanism of movement is predominantly downward in prestige. The line of reasoning, discussed previously, which suggests decreased mobility for the doctorate holder because of his specialization and subsequent competition for a limited number of positions may also be a part of the explanation. Perrucci has commented on the role of the institution attended in terms of a "prestige differentiation" which produces an "institutional effect" on an individual's career success and he notes:

> This "institutional effect" may either enhance individual factors such as ability and motivation in contributing to successful post college performance, or it may neutralize the contribution of individual factors to individual success. (1967, p. 145)

The present study findings suggest that "institutional prestige effects" are more significant than the level of degree earned in the matters of mobility. Eiduson's observation that scientists in general demand little support from persons outside their work situation and Roe's findings that physicists in particular are not interested in or very good at relating to people are in consonance with the study finding that congeniality of colleagues ranks first as an influence in the acceptance or continuance of employment. The importance of this influence can be understood by recognizing that "colleagueship is an interactional situation, the central focus of which is the facilitation of intellectual stimulation" (Taylor 1968, p. 414); and by acknowledging Eiduson's view of the scientific career:

> Once a man takes on a scientific career, he has, in essence, identified himself with a group whose whole rationale is tied up with intellectual rebellion, embodied in the rejection of old knowledge and a courageous search for the new. (1962, p. 249)

With these basic ideas, it is understandable that the emotional relationships physicists do have "are usually with other persons who share work interests and scientific experiences" (Eiduson, p. 94) and that "the group of colleagues is the most important source of social influence on research" (Hagstrom 1965, p. 1).

The low ranking of economic considerations in employment influences is in keeping with other research findings. Lansing and Mueller (1967, p. 87) reported "there is no convincing evidence that movers actually have lower incomes before the move or higher incomes after the move than non-movers," and Marshall found "our analysis suggests that economic factors are an important but not dominant element (1964, p. 128).

With the small amount of previous research that has been done in relation to job mobility, and particularly work with a theory emphasis, further comparative analysis is limited. To summarize, one rudimentary conclusion that may be drawn is that academic physicists, with an average of 2.6 employers (study result), are about as mobile as the general U. S. population who average 2.2 moves (Lansing and Mueller 1967), but they appear to be less mobile than scientists as a group who were reported to have had an average of 2.9 employers (U. S. Department of Labor 1953).

Some concluding comments of analysis and a summary of the study are given in the following chapter.

CHAPTER VI

SUMMARY

A study of the job mobility of academic physicists in American institutions of higher education offering a physics major to the baccalaureate level has been made within the theoretical framework of interacting social systems. From the statistical analysis of survey data on the family, work, and educational social systems a significant relationship has been found primarily between mobility and variables of the work system. An evaluation of factors influencing the acceptance or continuance of employment has shown that the most important sphere of influence is that of colleagueship and the least influential sphere is that of economic factors.

Study results show that mobility has a statistically significant relationship to age, academic rank, teaching activity, administrative activity, tenure, and books and articles published. The variables of highest degree and research activity did not show a statistically significant relation to mobility as had been expected. The strength of association between study variables and mobility, as measured by Cramer's statistic, and the predictability of mobility from data on variables, as measured by an index of predictive association are shown in table 29. These statistical measures show that the number of jobs, as a measure of mobility, is more significantly related to the study variables. Strengths of association for study variables and mobility have been shown to range

TABLE 29

MOBILITY VARIABLES--STRENGTH OF ASSOCIATION AND PREDICTABILITY

Variable	Number of Employers			Number of Jobs		
	Chi-square	CS	IPA	Chi-square	CS	IPA
Age	0.001	0.250	0.040	0.001	0.342	0.066
Marital status	n.s.	.117	zero	n.s.	.114	zero
Children	n.s.	.117	.029	n.s.	.148	.038
Academic rank	0.01	.188	.082	0.01	.321	.228
Research activity	n.s.	.150	.003	n.s.	.130	.006
Teaching activity	n.s.	.166	.019	0.05	.178	.033
Administrative activity	0.001	.214	zero	0.001	.240	.005
Books published	0.001	.210	zero	0.001	.200	zero
Articles published	n.s.	.163	.006	0.001	.197	.020
Highest degree	n.s.	.093	zero	n.s.	.114	zero

Notes: Numbers in chi-square column indicate level of statistical significance; n.s. means not significant at 0.05 level or less.

Cramer's statistic (CS) value of zero means variable and mobility are completely independent; a value of one means complete dependence. Index of predictive association (IPA) value of zero indicates that information about the variable does not reduce the probability of error in predicting mobility at all; a value of one indicates complete predictive association.

from slight to modest strengths (modest has been considered to be values 0.20 or greater). Only one variable, academic rank, showed any notable predictive relationship to mobility.

Survey data have shown that the basic pattern of mobility, in terms of prestige, is one with a direction from higher to lower prestige institutions, and that there is a relationship between the prestige of the highest degree awarding institution and the employing institution even when publications productivity is considered.

The dominant career pattern revealed by the study has been that of academic employment only, sixty percent of the cases, and this pattern combined with one of non-academic to academic employment makes up eighty-two percent of the total.

Of the seven hypotheses set forth at the end of chapter III only four have been shown to be acceptable by statistical tests at the 0.05 level of confidence: (1) mobility decreases with age, (2) mobility decreases after a tenured position is attained, (3) the prestige of the institution where an individual receives his degree correlates with the prestige of his employing institution even when the effects of his productivity are considered, and (4) the dominant pattern of inter-prestige mobility is downward in the prestige hierarchy (even after the expected downward move from degree granting to first employer institutions is excluded). The rejected hypotheses were that mobility increases with higher education degree attainment, that mobility decreases with increasing family responsibility, and that high publication productivity correlates with stable or upwardly directed interprestige mobility.

A search of the literature did not reveal a theory of job mobility which could be used as the theoretical framework of the study. The search

did show that the concept of mobility has been primarily a concern of sociologists; that until recent years it was not related to the study of the academic work world; and that the research which has been done is fragmentary, of limited theoretical emphasis, and to be found in several disciplines (sociology, psychology, education, and economics).

It has not been possible to construct a theory of job mobility from the study findings. The lack of significance in economic factors and the importance of interpersonal influences suggest that theories of mobility must include concepts in addition to "economic rationality" or even "prestige rationality." As the study is viewed in retrospect, a closing statement made by Cammack (1965, p. 67) comes quickly to mind: "A major result of the study has been the re-affirmation of the complexity of the academic market." This complexity, as evidenced in the study findings on mobility, probably stems from the fact that mobility is not only a rational process but a behavioral phenomenon as well. Eiduson has described the paradoxical nature of behavior:

> Clinical and experimental observation indicate that behavior is an apparent mixture and fusion of experiences proceeding simultaneously in many directions, and that many experiences are so indefinite and ambiguous that they are, at one and the same time, frustrating and gratifying, facilitating and hindering, and defensive and developmental. (1962, p. 17)

A vignette of the mobility of the academic physicist may be drawn from the study data. Having attained a doctoral degree, the young physicist is likely to take his first job at an institution whose prestige is less than that of his degree awarding institution, and this pattern of downward prestige mobility is dominant throughout careers. Dividing his work time among research, teaching, and administration, the young physicist tends to devote more time to research than older physicists. As his career develops there is a likelihood that he will emphasize

administration during mid-career and teaching later. Before attaining a tenured position he will probably have two employers and will have spent an average of four years with each one. The rate of mobility for the physicist is increasing up to about age 40 and then declines steadily as he approaches the retirement decade of the sixties. The majority of physicists will marry and have two children, but this responsibility appears to have little effect on their mobility. Greater mobility correlates with greater publications productivity. The factors which are most important to a physicist's acceptance of a new position are congenial, competent colleagues and an environment characterized by academic freedom and time for research. After forty years of age, the physicist is likely to stay with one employer and show job mobility by advancing in academic rank and/or acceptance of administrative positions. As he approaches retirement, he will probably have had four employers and five or six jobs. More than half of academic physicists will have spent their whole career in academe, and an additional one-fifth will have had the majority of their work experience in academic institutions.

In the preface to this study, a hope was expressed that the findings might be of some value to persons who are involved in the academic physics portion of the academic marketplace. To this end, the results set forth in the previous chapter could be used by individual physicists in evaluating their options for employment or by higher education administrators in recruiting physics faculty. Brown has noted that one cause of immobility in the academic marketplace is a folklore ethic "that too much mobility is bad per se, that the relatively stable teacher is the more marketable" (1967, p. 50). The data results of this study could be used by a physicist, having such concerns, as a normative guide and as a

relief from the fear of getting a reputation as "too mobile." The individual physicist could also use the results of the influence factors analysis as a guide in the evaluation of job opportunities; assuming the importance ratings given to the various factors are a valid representation, one has a checklist of important items to investigate. The reverse side of this usage is that by administrators in recruiting faculty. With an understanding of the relative importance given to the factors of colleagues, institutional setting, and economic items, an academic dean, for example, might emphasize certain things or allocate the resources under his control in a more effective manner. Beyond this usage administrators could use the study data, along with similar data on other disciplines, to construct a planning model for faculty development. Using linear regression analysis techniques and characteristics of currently employed faculty, predictions could be made about expected mobility. Such information could be used in formulating long range plans and budget proposals. As well as evaluating currently employed faculty, the mobility model could be used in the evaluation of prospective faculty members.

At the level of primary analysis, which has been used in this preliminary study of job mobility of academic physicists, one finds that the work social system dominates to such an extent that the family, economic, and educational systems appear to be low yield subjects for additional research on job mobility of academic physicists. A theory model which pictures job mobility within a prestige space governed by a dynamic of "prestige rationality" seems to be a valid concept which could be explored to a greater degree. The predominantly downward direction of interprestige movement reveals the realistic setting in which job changes take place and highlights the significance of the prestige of the highest

degree awarding institution in career development. The study results are generally consistent with an "exchange model" description of the work system, and consequently, it would seem that profitable further research could be done within a framework which combines the constructs of "prestige space" and an "exchange model."

APPENDICES AND LITERATURE CITED

APPENDIX I.—VOCATIONAL DEVELOPMENT THEORY

In Scientific Careers and Vocational Development Theory, Super and Bachrach (1957, p. 11) express the following theory propositions:

Proposition 1. Vocational development is an ongoing, continuous, generally irreversible process.

Proposition 2. Vocational development is an orderly, patterned, predictable process.

Proposition 3. Vocational development is a dynamic process.

Proposition 4. Self-concepts begin to form prior to adolescence, become clearer in adolescence, and are translated into occupational terms during adolescence.

Proposition 5. Reality factors play an increasingly important part in occupational choice with increasing age, from early adolescence to adulthood.

Proposition 6. Identification with a parent or parent substitute is related to the development of adequate roles, their consistent and harmonious interrelationship, and their interpretation in terms of vocational plans and eventualities.

Proposition 7. The direction and rate of vertical movement of an individual from one occupational level to another are related to his intelligence, parental socioeconomic level, status needs, values, interests, skill in interpersonal relationships, and the supply and demand conditions in the economy.

Proposition 8. The occupational field which the individual enters is related to his interests, values, needs, the identification he makes with parental or substitute role models, the community resources he uses, the level and quality of his educational background, and the occupational structure, trends, and attitudes of his community.

Proposition 9. Although each occupation requires a characteristic pattern of abilities, interests, and personality traits, there are tolerances wide enough to allow a variety of individuals in each occupation and some diversity of occupations for each individual.

Proposition 10. Work satisfactions and life satisfactions depend upon the extent to which the individual can find adequate outlets for his abilities, interests, values, and personality traits in his job.

Proposition 11. The degree of satisfaction the individual attains from his work is proportionate to the degree to which he has been able to implement his self-concept and satisfy his salient needs.

Proposition 12. Work and occupation provide a focus for personality organization for many men and women, although for some persons this focus is peripheral, incidental, or even nonexistant. In such persons other foci such as social activities and the home are central. Sex and socioeconomic factors play a part here.

APPENDIX II.--SURVEY INSTRUMENTS

The survey instruments (questionnaires, cover letters, and a reminder postcard) are assembled in this appendix in the following order:

(1) Cover letter for pilot sample questionnaire mailing,

(2) Pilot sample questionnaire,

(3) Cover letter for main sample questionnaire first mailing,

(4) Main sample questionnaire,

(5) Reminder post card (format),

(6) Note accompanying main sample questionnaire second mailing,

(7) Cover letter for main sample questionnaire third mailing.

THE UNIVERSITY OF MICHIGAN
CENTER FOR THE STUDY OF HIGHER EDUCATION
March 16, 1968

Dear Physics Faculty Member:

The enclosed questionnaire is a pre-test form of a research instrument which is to be used in a study of the job mobility of academic physicists in American higher education institutions that offer a physics major. It is hoped that this research will contribute to an understanding of the employment dynamics of academic physicists. Your participation in the study is invited and will be greatly appreciated.

For ease of completion, flowchart and multiple sorting techniques have been used in the questionnaire design. By tracing the flow lines through the data and test blocks of the education-employment segment, your responses should be individualized so that you consider only those parts which are pertinent to your chronologically ordered experiences. You are encouraged to use ditto marks and standard abbreviations when possible. Sequential steps of sorting in the influence factors segment should produce the required discriminations with minimum effort.

As you fill in the questionnaire, please feel free to pen comments, questions, and/or criticisms on the margins or on a separate sheet of paper. All information provided will be kept strictly confidential. The number on the form is for purposes of coding replies by state, institution, academic rank, and respondent. A summary report of the study findings may be obtained by marking the box provided on the last page of the questionnaire.

Please use the enclosed, self-addressed envelope to return your completed questionnaire by April 1st, if possible. This time boundary has been set so that your responses may be considered in revising the questionnaire before it is distributed to a large sample during April.

Thank you for your consideration.

Sincerely yours,
A. Lawrence Fincher
A. Lawrence Fincher

QUESTIONNAIRE: STUDY OF JOB MOBILITY OF ACADEMIC PHYSICISTS IN HIGHER EDUCATION

PART I. PERSONAL DATA

A. Personal Events List--Enter month and year for each applicable event. If an event occurred more than once, enter other dates to the right of the event.

Month	Year	Events
		Birth
		Marriage
		Birth of children
		Divorce, separation, or widowed(mark as D, S, or W)
		Receipt of bachelor's degree
		Receipt of master's degree
		Receipt of doctor's degree
		Attained academic tenure

B. Work Activity--Indicate with approximate percentages the amount of working time you currently devote to the following functions:

_____ Research

_____ Teaching

_____ Administration

_____ Other (please specify)_____

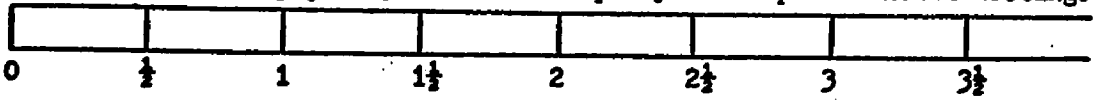
Check to see that total equals 100%.

C. Productivity--Enter appropriate numbers or marks in the spaces provided.

_____ Number of books and/or monographs published during your career.

_____ Number of articles you have had published in professional journals during your career.

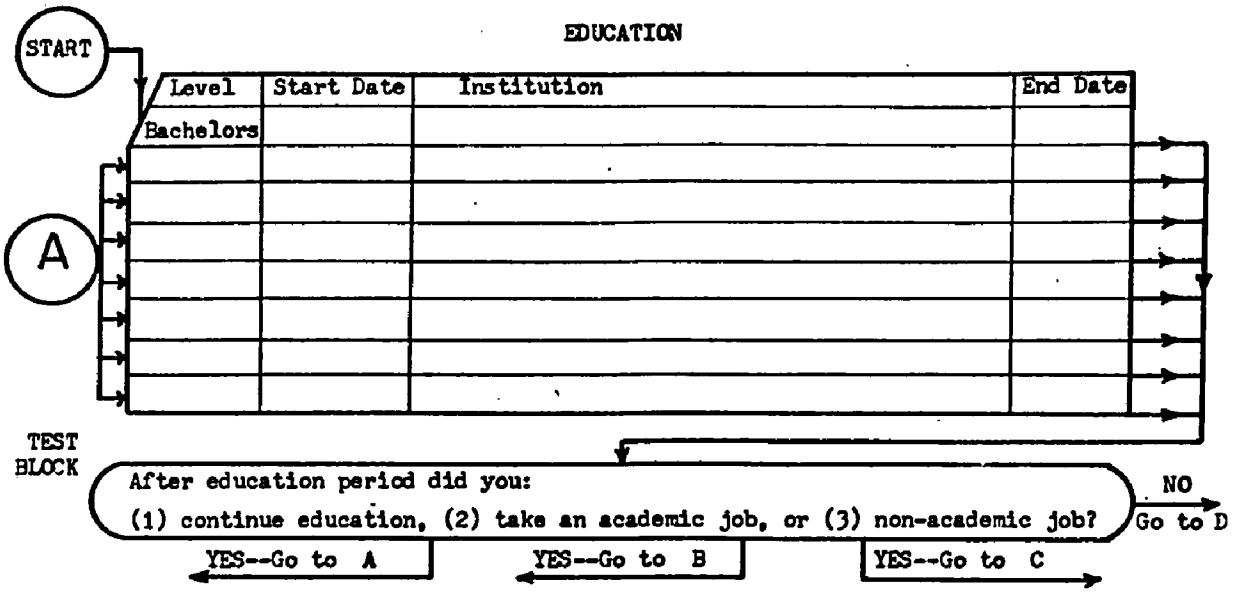
Place an A in the cell on the scale given below which corresponds to the average number of journal articles you have had published per year during your career. Similarly, place a P in the cell which corresponds to the average number of papers you have read per year at professional meetings.

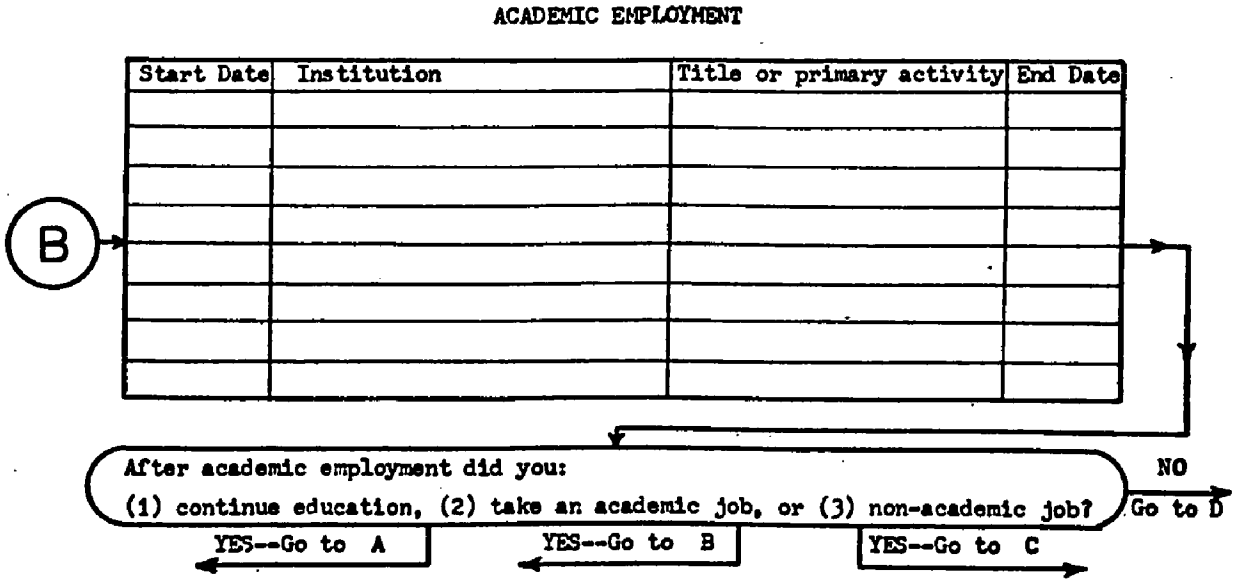


Briefly describe any other major activity of professional productivity in which you have engaged:

PART II. EDUCATION-EMPLOYMENT FLOWCHART

Instructions: Begin at the START circle below and chart your primary activity in a time sequence. After each line entry trace the flow line to the test block to determine a data block (A, B, C, or D) for a subsequent entry on the next available line. When a job title or primary activity changed, although with the same employer, chart it as a separate entry. Enter dates by month and year and use abbreviations where possible. When you have entered your present activity, go to data block E. Please attach an additional sheet if more space is needed.





NON-ACADEMIC EMPLOYMENT

C

Start Date	Employer and/or primary activity	End Date

After non-academic employment did you:
(1) continue education, (2) take an academic job, or (3) non-academic job?

NO
Go to D

YES--Go to A | YES--Go to B | YES--Go to C

OTHER ACTIVITY

D

Start Date	Activity	End Date

After this activity did you:
(1) continue education, (2) take an academic job, or (3) non-academic job?

NO
Go to D

YES--Go to A | YES--Go to B | YES--Go to C

CONCURRENT ACTIVITY

E

Significant secondary activities concurrent with any entry above may be entered here. If you have none to chart, this part is completed.

END

Start Date	Activity	End Date

PART III. INFLUENCE FACTORS IN EMPLOYMENT

A. Instructions: In the space provided before each factor assess its importance as an influence in the acceptance of your present job by placing a plus (+) before factors which had an above average influence, a zero (0) before those of an average influence, and a minus (-) before those of a below average influence. You may wish to append a qualifying adjective (good, bad, high, low, etc.) to some factors to clarify your assessment.

____ promotion and tenure policies	____ cultural aspects of community
____ size of institution	____ financial fringe benefits
____ retirement plan	____ community industry or business
____ expenses paid to meetings	____ nature of teaching spaces
____ academic freedom	____ faculty-student relations
____ prestige of department	____ faculty-chairman relationship
____ educational aspects of community	____ research funds or opportunities
____ committee or extra activities	____ advancement prospects
____ quality of students	____ recreational aspects of community
____ technical services	____ faculty role in policy making
____ financial aid for publication	____ office space
____ cost of living in community	____ nearness to friends or relatives
____ future salary prospects	____ non-financial fringe benefits
____ faculty-administration relations	____ time for research
____ climate or geography	____ choice in teaching assignment
____ congeniality of colleagues	____ secretarial services
____ competency of colleagues	____ level of teaching assignment
____ commuting and/or parking	____ emphasis on research
____ personal or family preference	____ prestige of institution
____ salary	____ reputation of a faculty member
____ nature of research facilities	____ contact hours of teaching
____ academic rank offered	____ research assistants
____ teaching assistants	____ emphasis on teaching
____ consulting-extra income prospects	____ teaching equipment and/or materials
____ library services	____ payment of moving costs

B. Reexamine the factors you marked above average and indicate by changing their mark to (++) six which you consider to have been a very important influence.

C. Reexamine the factors you marked below average and indicate by changing their mark to (--) six which you consider to have been of little importance.

D. Choose two factors from the six marked very important and designate them as the most important influences by changing their mark to a (+++).

E. Choose two factors from the six marked of little importance and designate them as the least important by changing their mark to a (---).

F. Reexamine the factors marked average and see if you wish to change any of them to above or below average.

THANK YOU!

____ Check here if you wish to receive a copy of the findings of this study.

THE UNIVERSITY OF MICHIGAN

CENTER FOR THE STUDY OF HIGHER EDUCATION

April 1968

Dear Physics Faculty Member:

The enclosed questionnaire is the primary research instrument which is to be used in a study of the job mobility of academic physicists in American institutions of higher education that offer a degree in physics. You have been selected as a respondent from a population defined by the Directory of Physics & Astronomy Faculties 1967-1968. It is hoped that this research will contribute to an understanding of the employment dynamics of academic physicists. Your participation in the study is invited and will be greatly appreciated.

For ease of completion, flowchart and multiple sorting techniques have been used in the questionnaire design. Your responses in PART II. EDUCATION-EMPLOYMENT FLOWCHART should be individualized by the flow lines and test blocks so that you consider only those flowchart segments which are pertinent to your chronologically ordered experiences. You are encouraged to use ditto marks and standard abbreviations in this part where possible. In PART III. INFLUENCE FACTORS IN EMPLOYMENT, sequential steps of sorting should produce the required discriminations with a minimum effort. Throughout the questionnaire, please enter N/A (not applicable) or zero, as appropriate, rather than leave an unmarked blank.

All information provided will be kept strictly confidential. No attempt will be made to associate individual names or institutions with responses, nor will institutions be specifically identified in reports of the study. The number on the first page of the questionnaire is for purposes of coding replies by state, institution, academic rank, and respondent.

Please use the enclosed, self-addressed envelope to return your completed questionnaire before May 15th, if possible. A summary report of the study findings may be obtained by marking the box provided on the last page of the questionnaire.

Thank you for your consideration.

Sincerely yours,

A. Lawrence Fincher

A. Lawrence Fincher

THE UNIVERSITY OF MICHIGAN
CENTER FOR THE STUDY OF HIGHER EDUCATION

QUESTIONNAIRE: STUDY OF JOB MOBILITY OF ACADEMIC PHYSICISTS IN HIGHER EDUCATION

PART I. PERSONAL DATA

A. Personal Events List--Enter month and year for each applicable event. If an event occurred more than once, enter other dates to the right of the event.

Month	Year	Events
		Birth
		Marriage
		Birth of children (or adoption)
		Divorce, separation, or widowed (mark as D, S, or W)
		Receipt of bachelor's degree (or equivalent degree)
		Receipt of master's degree (or equivalent degree)
		Receipt of doctor's degree (or equivalent degree)
		Attained academic tenure

B. Work Activity--Indicate with approximate percentages the amount of working time you currently devote to the following functions:

_____ Research

_____ Teaching

_____ Administration

_____ Other (please specify)_____

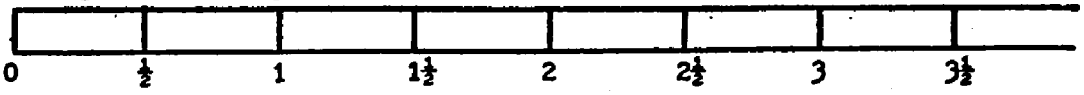
Check to see that total equals 100% .

C. Productivity--Enter appropriate numbers or marks in the spaces provided.

_____ Number of books and/or monographs published during your career.

_____ Number of articles you have had published in professional journals during your career.

Place an A in the cell on the scale given below which corresponds to the average number of journal articles you have had published per year during your career. Similarly, place a P in the cell which corresponds to the average number of papers you have read per year at professional meetings.

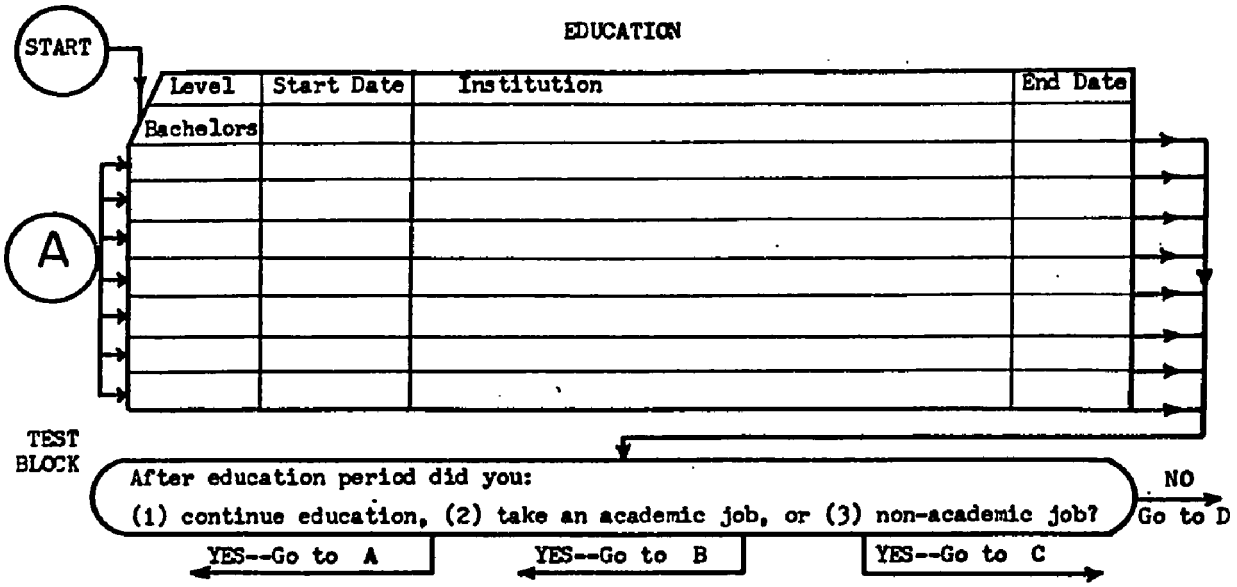


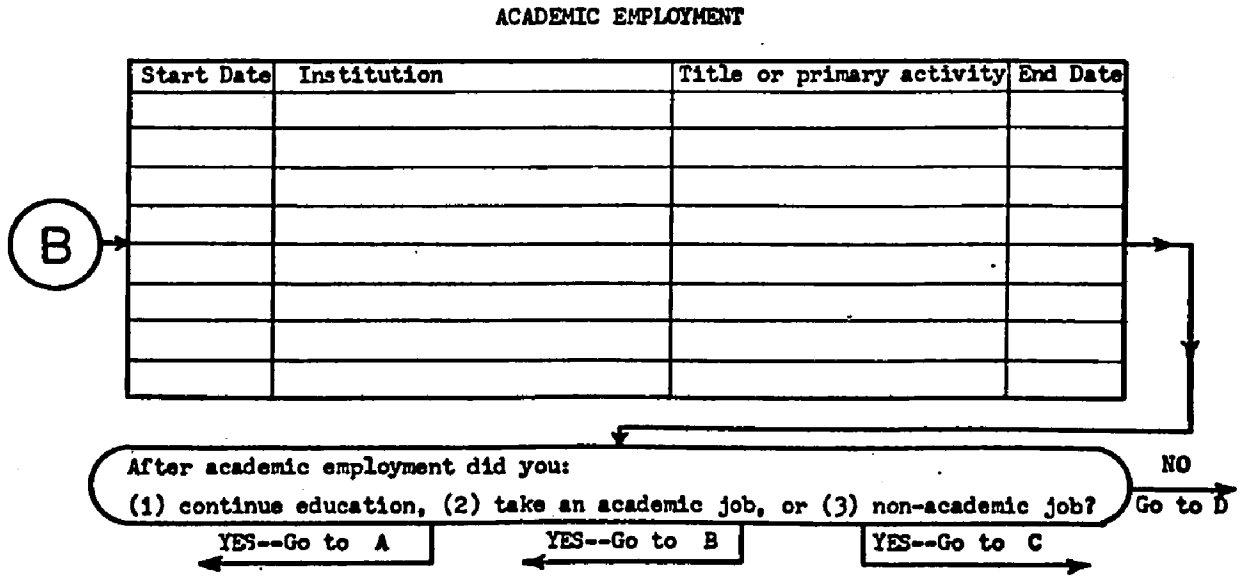
Briefly describe any other major activity of professional productivity in which you have engaged:

A.L. Fincher-519 Virginia-Ann Arbor, Mich. 48103 NUMBER:_____

PART II. EDUCATION-EMPLOYMENT FLOWCHART

Instructions: Begin at the START circle below and chart your primary activity in a time sequence. After each line entry trace the flow line to the test block to determine a data block (A, B, C, or D) for a subsequent entry on the next available line. When a job title or primary activity changed, although with the same employer, chart it as a separate entry. Enter dates by month and year and use abbreviations where possible. When you have entered your present activity, go to data block E. Please attach an additional sheet if more space is needed.





NON-ACADEMIC EMPLOYMENT

C

Start Date	Employer and/or primary activity	End Date

After non-academic employment did you:
(1) continue education, (2) take an academic job, or (3) non-academic job?

NO
Go to D

YES--Go to A | YES--Go to B | YES--Go to C

OTHER ACTIVITY

D

Start Date	Activity	End Date

After this activity did you:
(1) continue education, (2) take an academic job, or (3) non-academic job?

NO
Go to D

YES--Go to A | YES--Go to B | YES--Go to C

CONCURRENT ACTIVITY

E

Significant secondary activities concurrent with any entry above may be entered here. If you have none to chart, this part is completed.

END

Start Date	Activity	End Date

PART III. INFLUENCE FACTORS IN EMPLOYMENT

A. *Instructions:* In the space before each factor assess its importance as an influence in the acceptance of your present job by placing a plus (+) before those which had a considerable influence, a zero (0) before those of moderate influence, and a minus (-) before those of minimal influence. *Option:* If you have held your present job for a number of years, you may check here ____ and similarly mark factors for their importance in the continuance of your job. You may wish to append a qualifying adjective (high, low, heavy, light, etc.) to some factors to clarify your assessments.

____ promotion and tenure policies	____ cultural aspects of community
____ size of institution	____ financial fringe benefits
____ retirement plan	____ physical facilities for teaching
____ expenses paid to meetings	____ faculty-student relations
____ academic freedom	____ faculty-chairman relationship
____ prestige of department	____ research funds or opportunities
____ educational aspects of community	____ advancement prospects
____ committee or extra activities	____ recreational aspects of community
____ quality of students	____ faculty role in policy making
____ financial aid for publication	____ office space
____ cost of living in community	____ nearness to friends or relatives
____ future salary prospects	____ non-financial fringe benefits
____ faculty-administration relations	____ time for research
____ climate or geography	____ choice in teaching assignment
____ congeniality of colleagues	____ secretarial-technical aides
____ competency of colleagues	____ level of teaching assignment
____ commuting and/or parking	____ emphasis on research
____ personal or family preference	____ prestige of institution
____ salary	____ reputation of a faculty member
____ physical facilities for research	____ contact hours of teaching
____ academic rank	____ research assistants
____ teaching assistants	____ emphasis on teaching
____ consulting-extra income prospects	____ library holdings and services

____ _____
(Enter here any other factor of significance to you.)

B. Reexamine the factors you marked with a plus and designate six of them as very important influences by changing their mark to a double-plus (++).

C. Choose two factors from the six marked very important and designate them as the most important influences by changing their mark to triple-plus (+++).

D. Reexamine the factors you marked with a minus and designate six of them as not very important influences by changing their mark to a double-minus (--).

E. Choose two factors from the six marked not very important and designate them as least important influences by changing their mark to triple-minus (---).

F. Reexamine the factors you marked with a zero and see if you wish to change any of them to a plus or minus marking.

THANK YOU!

☐ Check here if you wish to receive a copy of the findings of this study.

REMINDER POSTCARD FORMAT

The University of Michigan
Center for the Study of Higher Education
May 1968

A few weeks ago you were sent a questionnaire--STUDY OF JOB MOBILITY OF ACADEMIC PHYSICISTS IN HIGHER EDUCATION. I would very much like to have your responses in the study if you wish to participate.

From my experience as an academic physicist, I know it is likely that you are busy now with activities ending the academic year. My request is that you include a few minutes (13 ± 3 should suffice) among your year closing activities to complete and return the questionnaire.

Thank you for your consideration.

A. Lawrence Fincher

REMINDER NOTE FORMAT

519 Virginia
Ann Arbor, Michigan 48103
June 15, 1968

Enclosed you will find a second copy of a questionnaire that was sent to you several weeks ago.

This follow-up action has been taken because I would like to include your responses in my study of the job mobility of academic physicists.

Your completion and return of the questionnaire would be appreciated, and even a partial completion would be helpful if you are pressed for time.

Questionnaire references to "current work activity", "present activity", and "present job" should be considered to apply to your situation during the 1967-68 academic year.

Thank you for your assistance.

Sincerely,

A. Lawrence Fincher

THE UNIVERSITY OF MICHIGAN
CENTER FOR THE STUDY OF HIGHER EDUCATION

October 1968

Dear Physics Faculty Member:

Last spring, as the academic year was coming to a close, you were sent a questionnaire concerning research on the job mobility of academic physicists. As a follow-up procedure, a reminder and a second copy of the questionnaire were mailed to you by mid-June. Realizing that the timing of these mailings may not have been convenient for some respondents, the present letter is being sent as a concluding request for your participation in the study.

Pertinent excerpts from the original cover letter are:

> For ease of completion, flowchart and multiple sorting techniques have been used in the questionnaire design. Your responses in PART II. EDUCATION-EMPLOYMENT FLOWCHART should be individualized by the flow lines and test blocks so that you consider only those flowchart segments which are pertinent to your chronologically ordered experiences. You are encouraged to use ditto marks and standard abbreviations in this part where possible. In PART III. INFLUENCE FACTORS IN EMPLOYMENT, sequential steps of sorting should produce the required discriminations with a minimum effort. Throughout the questionnaire, please enter N/A (not applicable) or zero, as appropriate, rather than leave an unmarked blank.
>
> All information provided will be kept <u>strictly confidential</u>. No attempt will be made to associate individual names or institutions with responses, nor will institutions be specifically identified in reports of the study. The number on the first page of the questionnaire is for purposes of coding replies by state, institution, academic rank, and respondent.

An additional copy of the questionnaire and a self-addressed, stamped envelope are enclosed for your convenience.

If you do not plan to complete the questionnaire, please assist me in assessing the non-response bias in the study by noting below your reason for not returning the questionnaire and return this letter to me.

Thank you.

Sincerely yours,

A. Lawrence Fincher

A. Lawrence Fincher

NON-RESPONSE REASON--I do not plan to return the questionnaire because:

APPENDIX III.--STATISTICAL MEASURES AND TABLES

Some additional detail on the statistical measures used in Chapter V and some contingency tables are to be found in this appendix.

The chi-square test for statistical association between two variables each of which may be classified in several categories is used on a data set giving the frequency of occurrence of the events described by the variables. An entire data set can be shown as a contingency table with C classes of variable A as columns and R classes of variable B as rows. An example of a 2 x 2 table would be as follows:

	A_1	A_2
B_1	(A_1 , B_1)	(A_2 , B_1)
B_2	(A_1 , B_2)	(A_2 , B_2)

The event (A_1 , B_1) might represent respondents who hold a rank of professor and have had one employer. Events in general for any number of variable classes may be represented as (A_j , B_k). Expected frequencies for a chi-square calculation have been expressed for a given cell in the contingency table as the product of the frequency in the column times the frequency in the row, divided by the total count. The defining equation for chi-square is given as

$$\text{chi-square} = \sum_{\substack{\text{over all} \\ \text{cells}}} \sum \frac{(\text{observed frequency} - \text{expected frequency})^2}{\text{expected frequency}}.$$

The number of degrees of freedom associated with a particular chi-square test is given by

$$\text{Degrees of freedom} = (R - 1)\,(C - 1)\,.$$

With a chi-square value calculated and the number of degrees of freedom determined, an evaluation of statistical association can be made for a specified level of probability from tables such as are given in Hays (1963, pp. 675-76) text on statistics.

Cramer's statistic has been used as an indicator of the strength of association between the variables of a contingency table. It is defined as

$$\text{Cramer's statistic} = \sqrt{\frac{\text{chi-square}}{\text{total count}\,(L - 1)}}$$

where L is the smaller of R or C. This statistical measure has a value of zero when the variables are completely independent and a value of one for complete dependence.

The index of predictive association has been used to indicate the extent one may predict a value of one variable given a value of another. Assuming information is given about A_j and one wishes to evaluate the extent to which a probability of error in predicting B_k is reduced by this information, the index of predictive association is defined as

$$\text{IPA} = \frac{\sum_{\text{With respect to } A_j} \text{largest frequency in column } A_j \;-\; \text{largest marginal frequency among rows } B_k}{\text{total count} \;-\; \text{largest marginal frequency among rows } B_k}$$

An IPA of zero indicates that information about A_j does not reduce the probability of error in predicting B_k at all, and an IPA of one indicates

complete predictive association.

Additional discussion of the statistical measures defined above may be found in Statistics by W. L. Hays (1963).

The following pages contain some additional data tables which were not included in Chapter V.

TABLE 30

MOBILITY AND ARTICLES PUBLISHED PER YEAR

Number of Articles Published Per Year	Mobility			
	Number of Employers		Number of Jobs	
	Mean	s.d.	Mean	s.d.
0 to $\frac{1}{2}$ (182)	2.73	1.71	3.55	2.11
$\frac{1}{2}$ to 1 (88)	2.20	1.38	2.92	1.91
1 to $1\frac{1}{2}$ (60)	2.32	1.24	3.25	1.66
$1\frac{1}{2}$ to 2 (41)	2.46	1.03	3.37	1.61
2 to $2\frac{1}{2}$ (25)	2.44	0.96	3.44	1.56
$2\frac{1}{2}$ to 3 (11)	2.40	1.35	4.27	2.72
3 to $3\frac{1}{2}$ (10)	2.80	1.23	3.90	1.79
Over $3\frac{1}{2}$ (18)	3.11	1.53	5.06	1.59

Notes: Chi-square is significant at the 0.05 level for NOE and at the 0.01 level for NOJ.

CS:NOE = 0.150; CS:NOJ = 0.173.

IPA:ARTICLE RATE--NOE = zero; IPA:ARTICLE RATE--NOJ = 0.004.

TABLE 31

MOBILITY AND PAPERS READ PER YEAR

Number of Papers Read Per Year	Mobility			
	Number of Employers		Number of Jobs	
	Mean	s.d.	Mean	s.d.
0 to $\frac{1}{2}$ (237)	2.67	1.61	3.47	2.02
$\frac{1}{2}$ to 1 (86)	2.30	1.37	3.26	1.99
1 to $1\frac{1}{2}$ (43)	2.42	1.22	3.42	2.05
$1\frac{1}{2}$ to 2 (30)	2.43	1.38	3.83	1.86
2 to $2\frac{1}{2}$ (19)	2.37	1.12	3.32	1.49
$2\frac{1}{2}$ to 3 (4)	2.00	1.41	3.00	1.41
3 to $3\frac{1}{2}$ (9)	2.56	1.42	3.67	1.80
Over $3\frac{1}{2}$ (7)	2.71	1.11	4.00	1.73

Notes: CS:NOE = 0.124; CS:NOJ = 0.121.

IPA:PAPERS RATE--NOE and IPA:PAPERS RATE--NOJ equal zero.

TABLE 32

CORRELATION MATRIX FOR SOME STUDY VARIABLES

	1	2	3	4	5	6	7	8	9	10
1	1.000	0.115	-0.206	-0.016	0.307	0.192	0.311	0.304	0.563	0.436
2		1.000	0.001	-0.029	0.103	0.023	0.141	0.134	0.162	0.098
3			1.000	-0.667	-0.205	0.004	0.298	0.316	-0.109	-0.126
4				1.000	-0.454	-0.095	-0.402	-0.424	-0.156	-0.025
5					1.000	0.158	0.253	0.269	0.372	0.185
6						1.000	0.182	0.441	0.146	0.148
7							1.000	0.956	0.249	0.085
8								1.000	0.258	0.106
9									1.000	0.810
10										1.000

Row and column numbers correspond to: (1) age interval, (2) number of children, (3) percentage of time devoted to research, (4) percentage of time devoted to teaching, (5) percentage of time devoted to administration, (6) number of books published, (7) number of articles published, (8) productivity interval, (9) number of jobs, and (10) number of employers.

APPENDIX IV.--PRESTIGE INDEX

An institutional prestige index based on quantitative data has been devised for use as a supplementary instrument of analysis. Data for the index have been taken from the eighth (1960), ninth (1964), and tenth (1968) editions of the American Council on Education publication--American Universities and Colleges. The index has been formed from nine factors which have been commonly used in previous studies that were concerned with institutional prestige.

In the literature of higher education, one may find several research efforts which have been concerned in whole or in part with an evaluation of the prestige or quality of academic institutions. Studies emphasizing the graduate level programming have been done by R. M. Hughes (1925), Hayward Keniston (1957), Bernard Berelson (1960), and A. M. Cartter (1966). In association with his study of academic mobility, Brown (1967, pp. 193-98) developed an index--The Prestige or Quality Per Student Index--to assess the interprestige characteristics of the moves of professors. This index was for total institutions without distinction between graduate and undergraduate levels. Another recent study with an institutional focus has been done by L. C. Howard in association with his research of "Title III Programs and Developing Institutions" (1967, pp. 81-106). The most recent study which has been examined is still in progress, but its use of a method of institutional ranking with a "scale of institutional differentiation" has been reported in a pilot study document (Parsons and Platt 1968, Chapter IV). Within the reports on the

research described above, one can find a considerable variety of methods and indexes. Cartter sent questionnaires to chairmen of departments, distinguished senior scholars, and knowledgeable junior scholars. Berelson included graduate deans, graduate faculty, recent recipients of the doctorate, college presidents, and representatives of industrial firms employing large numbers of holders of the doctorate in his sample of persons who were asked to evaluate the prestige of institutions. Questionnaires were distributed by Brown to a sample of 10,312 "newly hired" full-time faculty members at four-year institutions, while Parsons and Platt included whole departments from selected institutions in their sampling. The indexes range from simple listings to Markov chain and multiple regression analysis.

Three studies used quantitative data in formulating their prestige measure. Howard (1967, pp. 92-97) used five quantitative ratio factors: (1) students to faculty, (2) students to Ph.D."s on the faculty, (3) library volumes to enrollment, (4) income to enrollment, and (5) first-time enrollment to baccalaureates. These factors were evaluated by means of multi-regression analysis to determine how they should be weighted and were combined accordingly to "obtain the summary score for the institution." Brown (1967, pp. 195-96) used eight factors:

1. Percentage of faculty with Ph.D.'s.
2. Average compensation per faculty member.
3. Percentage of students continuing to graduate school.
4. Percentage of students studying at the graduate level.
5. Number of volumes in the library per full-time student.
6. Total number of full-time faculty members.
7. Faculty-student ratio.
8. Total current income per student.

The prestige index derived from these factors is such that:

> The overall prestige rating represents the unweighed mean of the ratings received on each of the eight factors. Each institution is ranked against all other institutions on each of the factors;

> thus, for each variable an institution may receive a rank between 1 and 1,121, with the lower rank representing the better school. By averaging these eight individual ranks, an overall rank, or composite rating, is obtained for each school. (pp. 194-95)

In the "scale of institutional differentiation" used by Parsons and Platt (1968, Chapter IV), factors of size, quality, and research orientation were combined according to the prescription:

> High quality and high research orientation were assigned a plus one (+1), while low quality and research orientation were assigned a zero (0). Size followed a similar assignment of values; large, one (+1); medium, one half (+½); and small size, zero (0). We decided to add the values for each dimension equally, since we had no theoretical justification for proceeding otherwise. (p. IV-7)

Within the factor of quality were subsumed (1) educational and general income per student; (2) the proportion of Ph.D. holders on the faculty; and (3) the student-faculty ratio, and within research orientation (1) the percentage of the arts and sciences student body that are graduate students; (2) the monetary amount of grants received by an institution per faculty member; and (3) the number of periodicals per faculty member (pp. IV-12 and IV-14).

Cartter (1966, pp. 111-15) examined his institutional ratings which were based on subjective assessments by comparing them to several factors. He found that the correlation between average faculty compensation and institutional rating was "significantly high" ($r = 0.983$) (pp. 111-12) and that a strong correlation ($r = 0.794$) existed between the ratings and his library resources index--a measure composed of total volumes, volumes added, and periodicals (pp. 114-15). In Howard's study (1967, p. 91) six factors were found to have high intercorrelations--total number of faculty, percentage of faculty with doctorates, total library volumes, total annual income, total number of majors, and total number of males receiving bachelors degrees; however, Howard did not con-

sider this to be a good working model of quality ranking because it seemed to be primarily a composite of volume indicators (p. 91). Subsequently he used the ratio measures which were previously identified but he felt that even these did not result in a model which could clearly identify "developing institutions." Parsons and Platt (1968) compared their scheme of ranking to Brown's rankings and to a ranking produced by Alexander Astin (1962) from questionnaires that were distributed to college students, and they found "the relationship between Brown's ranking and our SID is .73 (N = 120) and with Astin's .66 (N = 115" (p. IV-22).

From previous research one finds that there is no generally accepted method or index for the assessment of quality of higher education institutions. Brown speaks of an "ideal measure" of prestige which is determined by asking "all scholars to rate all schools in the country," and Cartter and Berelson have emphasized this qualitative approach. Brown, Howard, and Parsons and Platt have used more objective factors and have derived rankings from quantitative data.

The prestige index which has been constructed for use in this study represents an attempt to incorporate the positive findings from the research described above and the common factors of students, faculty, books and dollars into a reliable measure of institutional prestige.

The nine factors which have been used in the index are a:

(1) ratio of full-time-equivalent (FTE) faculty to FTE students,
(2) ratio of faculty with a doctoral degree to the total faculty,
(3) scale value representing faculty compensation (salary plus fringe benefits),
(4) ratio of FTE graduate students to FTE undergraduate students,
(5) scale value for the total number of library volumes,
(6) scale value for the number of library periodicals per FTE faculty,
(7) ratio of library volumes added in the previous four years to the number of volumes presently held,
(8) scale value for the number of dollars of "educational and general" income per FTE student,

(9) scale value for the number of dollars of "contract or sponsored research" income per FTE faculty member.

Each factor has been scaled to have values between 0 and 1 when it did not naturally have such a range (scaling is explained in the following paragraphs). Data was compiled for all institutions in which a respondent had received a degree or had been employed during the period 1958 to 1968. This data was grouped according to the editions of American Universities and Colleges and corresponded roughly to institutional characteristics in 1958, 1962, and 1966. Data on faculty compensation was taken from the annual reports of the American Association of University professors on "The Economic Status of the Profession" (1967, 1963, 1959).

Prestige index values were computed (see computer program pp. 142-46) for each set of data so that values were obtained essentially for the academic years 1958-59, 1962-63, and 1966-67. The computation of prestige values took missing data into consideration and required a minimum of complete information for five factors. The prestige value was calculated as the mean of the individual factor values and had a range, in principle, from zero to one. To make the index values computed for the different years comparable they were expressed in terms of a standard score (0-100). As an overall time-independent measure of prestige a mean was computed for the three standard scores (see table 33 for some illustrative values of the prestige index).

Details of the factor value computations are given in the following paragraphs. (An asterisk has been used to signify multiplication.)

FACTOR (1)--FACULTY TO STUDENT RATIO. This ratio has been computed as the ratio of the full-time equivalent faculty members count

TABLE 33

ILLUSTRATIVE PRESTIGE INDEX VALUES

Institution	Index Values			Standard Scores			Mean of Standard Scores
	1958	1962	1966	1958	1962	1966	
Alabama A & M College	0.086	0.100	0.110	39.3	38.4	34.1	37.2
Univ. of Toledo	.112	.136	.173	43.6	43.4	42.9	43.3
Eastern Michigan Univ.	.138	.142	.179	48.8	52.7	46.8	49.4
Oberlin College	.185	.218	.217	56.1	54.9	49.0	53.3
Univ. of Illinois	.204	.244	.276	59.4	58.6	57.2	58.4
Univ. of Michigan	.275	.302	.325	71.6	66.6	64.0	67.4
Harvard University	.345	.388	.456	83.6	78.7	82.2	81.5
Calif. Inst. of Tech.	.413	.424	.473	95.1	83.8	84.5	87.8
Univ. of Chicago	.343	.541	.544	83.2	100.0	94.4	92.6

(FTEFAC) to the full-time equivalent students count (FTESTU). The FTEFAC in turn has been computed as the sum of the full-time faculty count (DATA(1)) and thirty percent of the part-time faculty count (DATA(2)). Similarly, the FTESTU has been computed as the sum of the full-time undergraduate (DATA(6)) and graduate (DATA(8)) counts plus forty percent of the sum of the part-time undergraduate (DATA(7)) and part-time graduate (DATA(9)) counts.* Equations for these computations are

FTEFAC = DATA(1) + 0.3 * DATA(2)

FTESTU = DATA(6) + DATA(8) + 0.4 * (DATA(7) + DATA(9))

FACTOR(1) = FTEFAC / FTESTU .

This factor will have a value of <u>one</u> for a tutorial situation of one faculty member per student and approaches <u>zero</u> when one faculty member must teach a large number of students.

FACTOR(2)--PROPORTION OF FACULTY WITH DOCTORATES. This factor has been computed by dividing the count of faculty members with the doctorate (DATA(3)) by the sum of the counts for the full-time and part-time faculty (DATA(1) + DATA(2)). Expressed as an equation this is

FACTOR(2) = DATA(3) / (DATA(1) + DATA(2)) .

When all faculty members have the doctorate this factor has a value of <u>one</u> and a value of <u>zero</u> when no faculty member has a doctorate.

FACTOR(3)--FACULTY COMPENSATION. Data for this factor have been taken from reports of the annual AAUP surveys of faculty compensation and have been converted from alphabetical ratings to numerical scores by equating AA = 9, A = 8, B = 7, C = 6, D = 5, E = 4, F = 3, and G = 2.

---

*The multipliers used to convert part-time counts into full-time equivalents follow the usage by Brown (1967) for students and the usage of the U.S. Office of Education (1964) for faculty.

The data have been recorded as a composite of the average compensation grade and the minimum compensation grade; for example, an institution with an average grade of A and a minimum grade of B would be given a numerical score of 87, grades of D and C would score 56, etc. This means of conversion gives the major weight to the average compensation grade, but it also gives credit for a high minimum grade. An institution that had been graded AA in both areas would result in a factor value of essentially one, and an institution receiving the lowest grades in each area would result in a value of 0.22 after the scores had been scaled by a multiplier of 10^{-2} according to the computation equation,

FACTOR(3) = 0.01 * DATA(5) .

FACTOR (4)--PROPORTION OF GRADUATE STUDENTS IN THE STUDENT BODY. In computing this factor, the full-time equivalent graduate student count is divided by the full-time equivalent student count, or in equation form

FACTOR(4) = (DATA(8) + 0.4 * DATA(9)) / FTESTU .

An exclusively graduate student body would result in a value of one for this factor and an absence of graduate students in a value of zero.

FACTOR(5)--LIBRARY VOLUMES FACTOR. Since the data for this factor ranges from about eight million to tens of thousands of volumes, a multiplier of 10^{-7} has been used to scale the factor values; thus, ten million volumes would result in a factor value of one and less than one hundred thousand volumes would result in a value near zero. For computational convenience the number of volumes data (DATA(10)) have been recorded in units of thousands and the factor value computed as

FACTOR(5) = 0.0001 * DATA(10) .

FACTOR(6)--PERIODICALS PER FACULTY MEMBER. Data for this factor range from tens of thousands to hundreds of periodicals per faculty member. To scale this factor a multiplier of 10^{-2} has been used and factor values have been computed with the equation

FACTOR(6) = 0.01 * DATA(11) / FTEFAC .

The number of periodicals (DATA(11)) and the FTEFAC are such that approximately 100 periodicals per faculty member give a factor value near one and a few periodicals per faculty member approaches zero.

FACTOR(7)--LIBRARY VOLUMES ADDED. This factor has been computed by dividing the number of volumes added (DATA(13)) by the number of volumes held, or in equation form

FACTOR(7) = DATA(13) / DATA(10) .

When the number of volumes added is equal to the number previously held this factor has a value of one and a value of zero for no volumes added.

FACTOR(8)--EDUCATIONAL AND GENERAL INCOME PER STUDENT. The educational and general income data (DATA(14)) in units of thousands of dollars have been used to compute these factor values with the equation

FACTOR(8) = 0.1 * DATA(14) / FTESTU .

The actual values for this factor range from hundreds of dollars per student to thousands of dollars per student; thus the scaled factor value will have a value of one when the actual value is $10,000 per student, data have been recorded in units of thousands of dollars, and a scaling multiplier of 10^{-1} is used. With only a few hundred dollars per student as the actual value, the scaled value is nearly zero.

FACTOR(9)--CONTRACT RESEARCH INCOME PER FACULTY MEMBER. Data on contract research income (DATA(15)) have been recorded in units of

thousands of dollars and the factor values have been computed with the equation

FACTOR(9) = 0.01 * DATA(15) / FTEFAC .

Actual factor values in this case range from thousands to tens of thousands of dollars per faculty member, thus the scaled factor value will be one for an actual value of $100,000 per faculty member when data are recorded in units of thousands of dollars and a scaling multiplier of 10^{-2} is used. Actual factor values of less than a thousand dollars per faculty member approach a zero value.

The computer program written to compute prestige index values is described in the following pages with an annotated listing of the program statements. In writing the program, symbols or variable representations were made as explanatory as possible (e.g., FTEFAC is the representation for full-time equivalent faculty) within the restriction of the Fortran computer language that they may not exceed six characters. Most of the representations used have been defined in the text of the previous paragraphs which explain the calculation of the individual factors (see table 34 for a complete listing of symbols).

TABLE 34

COMPUTER PROGRAM SYMBOLS

Symbol	Variable Represented
DATA	Any one of the fifteen items of input data*
DENOM	Denominator in prestige index computation
FACTOR	Any one of the nine factors used in the index*
FTEFAC	Full-time equivalent faculty count
FTESTU	Full-time equivalent student count
NAME	Name of a given institution
PRESIN	Prestige index
SUMFAC	Sum of factors used in index computation

*Specific identifications of data or factors, when not made evident by context, may be found in the discussion of factors on the immediately preceding pages.

ANNOTATED LISTING OF COMPUTER PROGRAM STATEMENTS

(Program statements are given in capitals and are preceded by explanatory notes.)

This program computes prestige index values.

Storage spaces for subscripted variables are reserved with a DIMENSION statement.

```
DIMENSION NAME(7), FACTOR(9,3), SUMFAC(3), DENOM(3), PRESIN(3), DATA(16,3)
```

Written expression on the output sheets is provided with a WRITE statement. The arrangement of these expressions is governed by a FORMAT statement. The following four statements taken together print out a heading (Prestige Index Values) and column labels (Institution, 1958-59, 1962-63, and 1966-67).

```
WRITE(6,100)
100 FORMAT(1H1, 21X, 21HPRESTIGE INDEX VALUES/)
WRITE(6,101)
101 FORMAT(1H , 11HINSTITUTION, 24X, 7H1958-59, 5X, 7H1962-63, 5X, 7H1966-67/)
```

Repetition of a process may be accomplished with a DO statement and specification of indices I and J. The following set of statements places a value of zero in all FACTOR storage spaces.

```
1 DO 10 I = 1,9
      DO 20 J = 1,3
      FACTOR(I,J) = 0.
20    CONTINUE
10 CONTINUE
```

In a similar manner , zero values are placed in the SUMFAC and PRESIN storages.

```
DO 30 I = 1,3
      SUMFAC(I) = 0.
      PRESIN(I) = 0.
30 CONTINUE
```

Values of the index denominators are set to nine at the start of the program.

```
DO 40 I = 1,3
    DENOM(I) = 9.
40 CONTINUE
```

Data for the program is input by a READ statement and controlled by a FORMAT statement. The following statements input all data required to compute three index values and the institutional name.

```
READ(5,102) (NAME(N), N = 1,7), ((DATA(I,J), J = 1,3), I = 1,16)
102 FORMAT(7A4, 2X, 9F5.0, 2X, 3F1.0/2X, 3F2.1, 12F6.0/2X, 3F5.4, 3F6.2, 1X, 3F1.0, 3F5.4,
          3F6.1, F6.2, 2X/2X, 2F6.2, 1X, 3F1.0)
```

Prestige index values are computed in a DO loop process beginning as follows.

```
2 DO 50 J = 1,3
```

Within the DO loop a large number of tests, options, and calculations are processed. The IF statement is used to test for missing data or to evaluate an alternate expression of data.

A test is made to see if a complete set of data is missing for a given year. Associated with the test are GO TO statements which cause some portions of the program to be omitted. When a set of data is missing, the corresponding PRESIN variable is set to a value of -9.0 and the program continues in the loop starting at the first of the loop again. The notations ".GT.", ".LT.", and ".EQ." respectively mean "greater than", "less than", and "equals".

```
IF(DATA(16,J).GT.0.)  GO TO 3
GO TO 4
3 PRESIN(J) = -9.
GO TO 50
```

The full-time faculty equivalent count is computed from data on full and part time faculty counts.

```
FTEFAC = DATA(1,J) + 0.3 * DATA(2,J)
```

The full-time equivalent student count is similarly computed.

```
FTESTU = DATA(6,J) + DATA(8,J) + 0.4 * (DATA(7,J) + DATA(9,J))
```

The faculty to student ratio is computed.

```
FACTOR(1,J) = FTEFAC/FTESTU
```

Tests are made to see if data on faculty doctorates is missing or if it is given for full-time faculty only. Appropriate omissions are made and the index denominator is decreased by one if it should be.

```
IF(DATA(3,J).LT.0.)  GO TO 6
IF(DATA(4,J).GT.0.)  GO TO 5
FACTOR(2,J) = DATA(3,J) / (DATA(1,J) + DATA(2,J))
GO TO 7
5 FACTOR(2,J) = DATA(3,J) / DATA(1,J)
GO TO 7
6 DENOM(J) = DENOM(J) - 1.
```

For the remainiing factors, the general procedure is a test for missing data with an appropriate index denominator reduction and computation of the factor.

For the faculty compensation factor:

```
7 IF(DATA(5,J).LT.0.)  GO TO 8
FACTOR(3,J) = DATA(5,J)
GO TO 9
8 DENOM(J) = DENOM(J) - 1.
```

For the factor related to the graduate to undergraduate enrollment ratio:

```
9 IF(DATA(8,J).EQ.0. .AND. DATA(9,J).EQ.0.)  GO TO 11
FACTOR(4,J) = (DATA(8,J) + 0.4 * DATA(9,J) / FTESTU
GO TO 12
11 DENOM(J) = DENOM(J) - 1.
```

For the library volumes factor:

```
12 IF(DATA(10,J).LT.0.)  GO TO 13
```

```
      FACTOR(5,J) = DATA(10,J)
      GO TO 14
   13 DENON(J) = DENOM(J) - 1.
```

For the library periodicals per faculty member factor:

```
   14 IF(DATA(11,J).LT.0.)  GO TO 15
      FACTOR(6,J) = DATA(11,J) / FTEFAC
      GO TO 16
   15 DENOM(J) = DENOM(J) - 1.
```

For the library volumes added factor:

```
   16 IF(DATA(13,J).LT.0.)  GO TO 17
      IF(DATA(12,J).GT.0.) DATA(13,J) = 4. * DATA(13,J)
      FACTOR(7,J) = DATA(13,J) / DATA(10,J)
      GO TO 18
   17 DENOM(J) = DENOM(J) - 1.
```

For the educational and general income per student factor:

```
   18 IF(DATA(14,J).LT.0.)  GO TO 19
      FACTOR(8,J) = DATA(14,J) / FTESTU
      GO TO 21
   19 DENOM(J) = DENOM(J) - 1.
```

For the research income per faculty member factor:

```
   21 IF(DATA(15,J).LT.0.)  GO TO 22
      FACTOR(9,J) = DATA(15,J) / FTEFAC
      GO TO 23
   22 DENOM(J) = DENOM(J) - 1.
```

A test is made to see if the index denominator has been reduced below five, and when it has the PRESIN value is set to -5.0 to indicate no value is computed for less than five factors.

```
23 IF(DENOM(J).LT.5.)  GO TO 24
GO TO 25
24 PRESIN(J) = -5.
GO TO 50
```

The factor values are summed with a DO loop.

```
25 DO 60 K = 1,9
     SUMFAC(J) = SUMFAC(J) + FACTOR(K,J)
60 CONTINUE
```

The prestige index is computed, and the loop termination statement is reached.

```
PRESIN(J) = SUMFAC(J) / DENOM(J)
50 CONTINUE
```

The prestige index values are printed on the output page along with the institutional name.

```
WRITE(6,103) (NAME(N), N = 1,7), (PRESIN(J), J = 1,3)
103 FORMAT(1HO, 7A4, 7X, 3(F7.4, 5X))
```

A transfer statement causes the program to return to the point of placing zeroes in variable storages and proceeds to read in data for another institution. This process continues until the data on institutions is exhausted.

```
GO TO 1
STOP
END
```

APPENDIX V--PRODUCTIVITY INDEX

The basic measure of professional productivity is a communication, usually in written form, of the work activity which has been performed. Hagstrom (1965, p. 56) has used a count of the articles and books (count one book as five articles) published in a three year period and designates 6 or more as high productivity, 3 to 5 as moderate, and less than 3 as low. Roe reported on productivity of physicists in terms of publications noting:

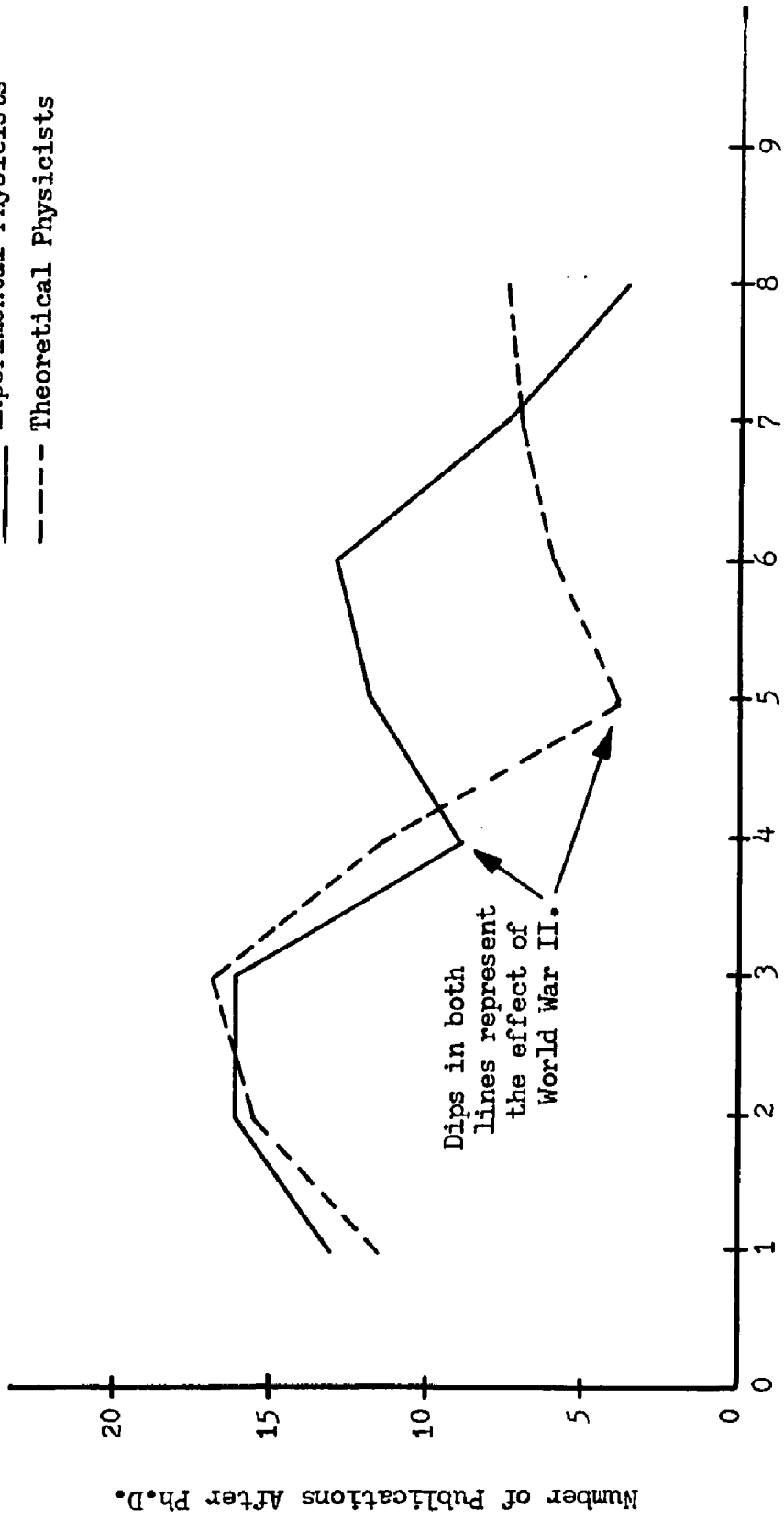
> Measures of scientific productivity are difficult to arrive at, but Dennis has shown that one of the crudest, count of numbers of publications, is not a bad one. (1964, p. 63)

Roe's data (see Figure 6) provide a measure of the order of magnitude of productivity rate and total (2 articles per year) and shows the productivity pattern (Super (1957, p. 3) has described:

> The natural scientist does his most productive work at a fairly early age, varying with his field but typically between thirty and thirty-five. However, he keeps on being productive longer than the average man.

The productivity index used in the study has been constructed to provide a measure of overall professional productivity by including total articles and books published, average rate of article publication, average rate of paper presentation at professional meetings, and other major productivity such as national organization committee work and government service. Numerical values of the index have been calculated as a sum of points according to the following:

One point per article published;



(Data from Roe 1964, pp. 65-66)

Fig. 5--Publication by Physicists

Five points per book published;
One to eight points according to rate of article publication;*
One to eight points according to rate of papers read;*
One to five points for other productivity.**

This scheme of point assignment led to productivity index values which ranged from 2 to 178. For convenience of analysis these values were scaled so as to have ten approximately equal parts of the sample (see table 35).

TABLE 35

PRODUCTIVITY INDEX INTERVAL SCALE

Index Value	Scale Number
2	0
3-4	1
5-6	2
7-9	3
10-14	4
15-19	5
20-29	6
30-39	7
40-49	8
50 plus	9

One would expect to find a relationship between productivity and mobility which shows greater mobility associated with greater productivity (see table 36). The statistical significance of the productivity

---

*Point assignments for these rates were made in accord with the "cells" on page one of the main sample questionnaire: 0-$\frac{1}{2}$ items = 1 point; $\frac{1}{2}$-1 items = 2; 1-1$\frac{1}{2}$ items = 3; 1$\frac{1}{2}$-2 items = 4; 2-2$\frac{1}{2}$ items = 5; 2$\frac{1}{2}$-3 items = 6; 3-3$\frac{1}{2}$ items = 7; and over 3$\frac{1}{2}$ items = 8.

**One point was assigned for each "other major activity of professional productivity" listed on page one of the main sample questionnaire.

association follows the same pattern as dis articles alone--the significance level is greater for NOJ than for NOE, the strength of association is modest, and the predictive association is only slight.

TABLE 36

MOBILITY AND PRODUCTIVITY

Productivity Interval Scale Number	Mobility			
	Number of Employers		Number of Jobs	
	Mean	s.d.	Mean	s.d.
0 (63)	2.75	1.58	3.17	1.78
1 (64)	2.34	1.51	3.17	1.88
2 (44)	1.80	0.98	2.27	1.50
3 (46)	2.39	1.71	3.09	2.25
4 (51)	2.29	1.38	3.00	1.78
5 (40)	2.65	1.63	3.62	2.14
6 (47)	2.83	1.34	3.91	1.67
7 (31)	3.06	1.31	4.61	1.86
8 (14)	2.93	1.44	4.00	1.47
9 (36)	2.80	1.43	4.89	1.86

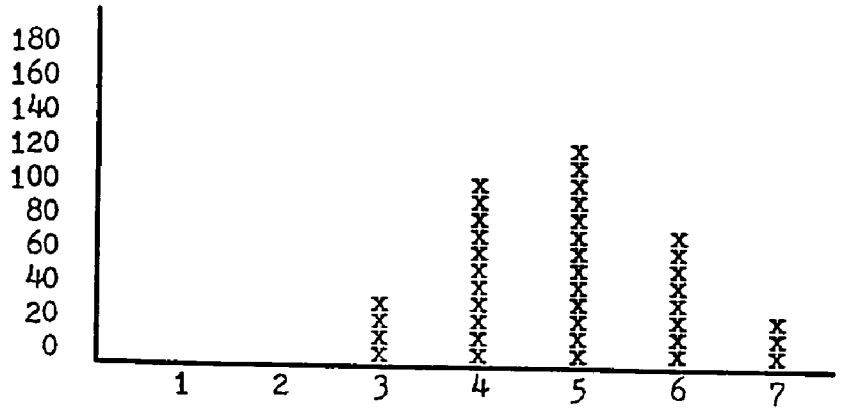
Notes: Chi-square is significant beyond 0.001 level for NOJ, and at the 0.01 level for NOE.

CS:NOE = 0.185; CS:NOJ = 0.202.

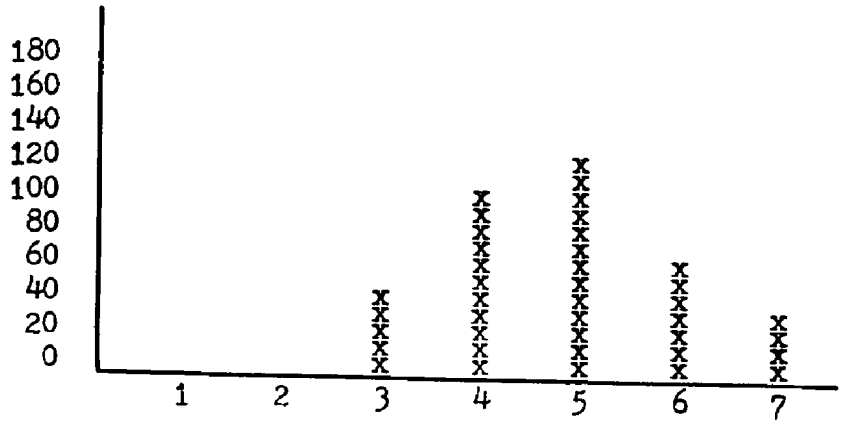
IPA:PRODUCTIVITY--NOE = 0.057; IPA:PRODUCTIVITY--NOJ = 0.054.

APPENDIX VI.--JOB INFLUENCE FACTORS HISTOGRAMS

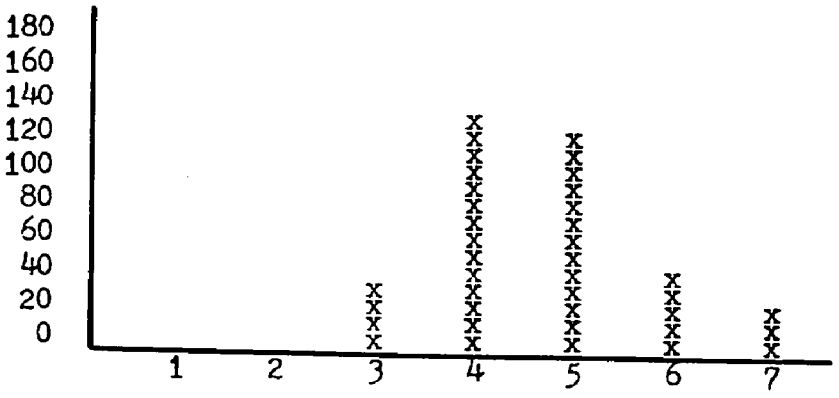
The frequency distributions of responses for each job influence factor included in Part III of the main sample questionnaire are given in the histograms contained in this appendix. Each plot has the importance rating (scaled from least important designated by <u>one</u> to most important designated by <u>seven</u>) as an horizontal axis and has the count of respondents marking each importance category (plotted to the nearest ten units) as the vertical axis. The histograms are arranged in the decreasing order of factor rankings given in table 23.



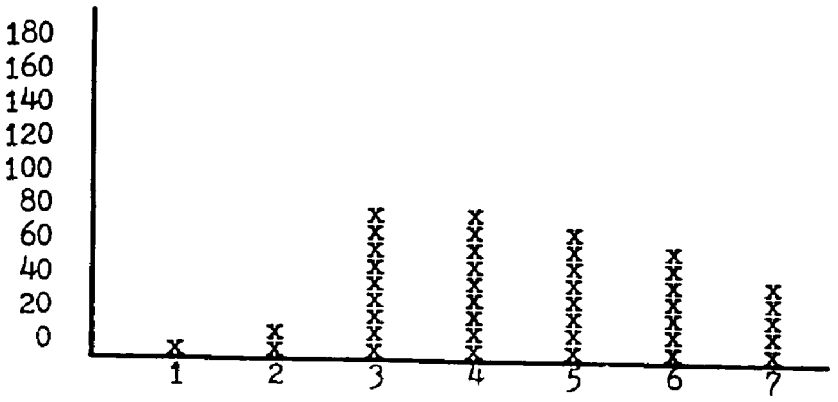
Histogram 1--Congeniality of Colleagues



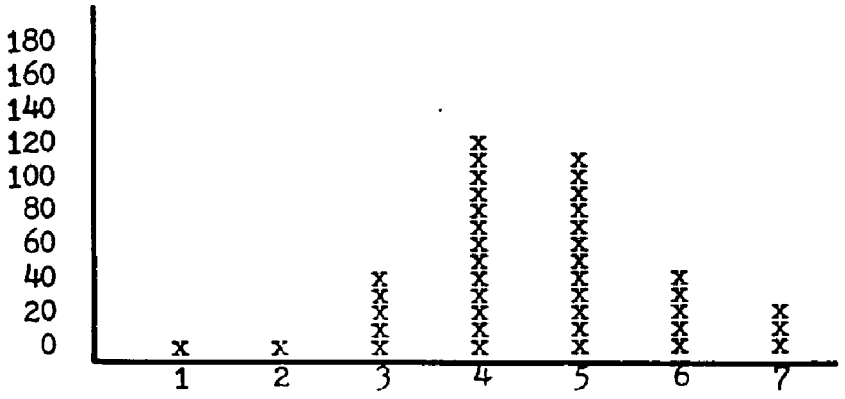
Histogram 2--Academic Freedom



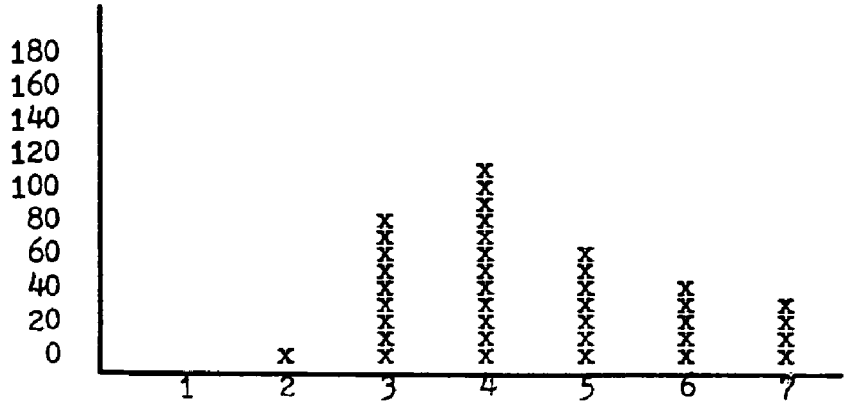
Histogram 3--Competency of Colleagues



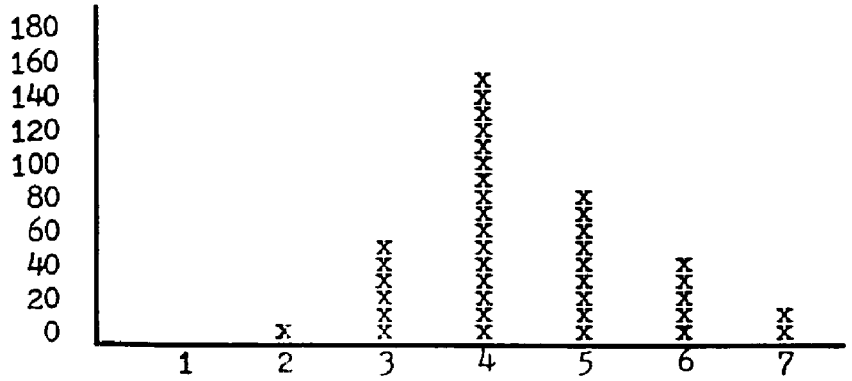
Histogram 4--Time for Research



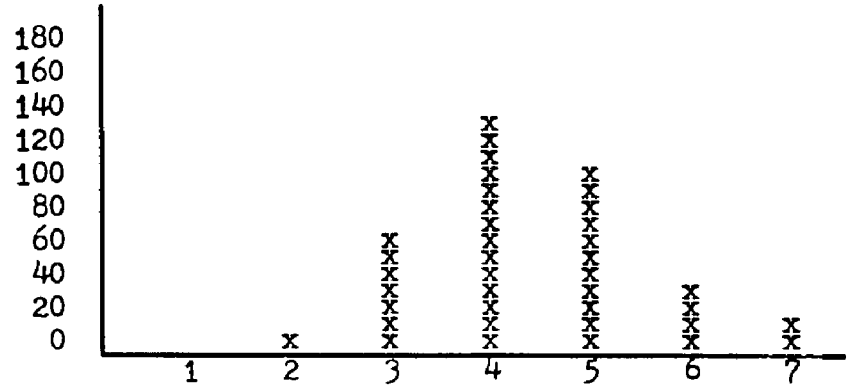
Histogram 5--Size of Institution



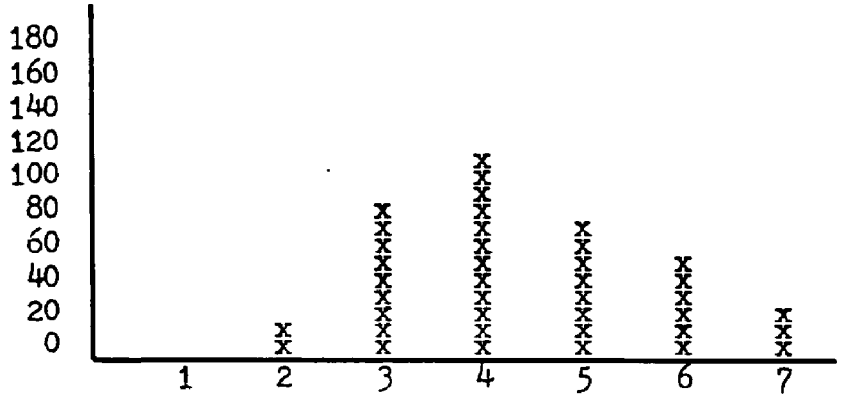
Histogram 6--Emphasis on Teaching



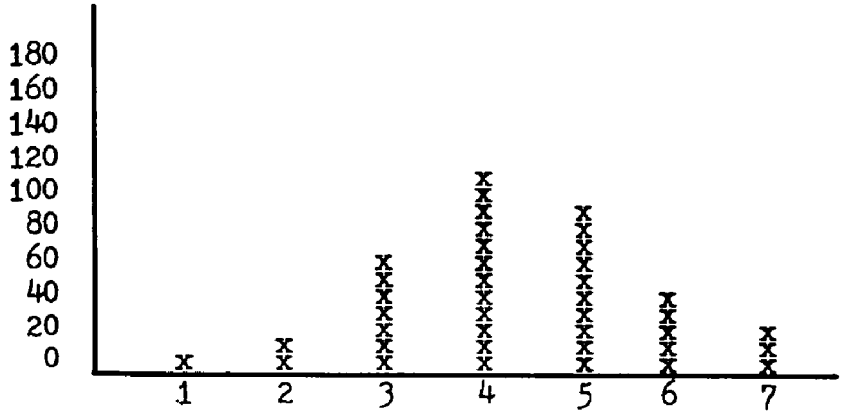
Histogram 7--Salary



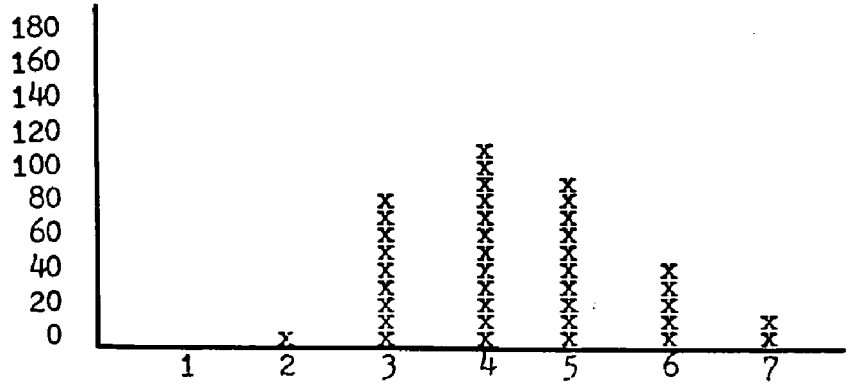
Histogram 8--Choice in Teaching Assignment



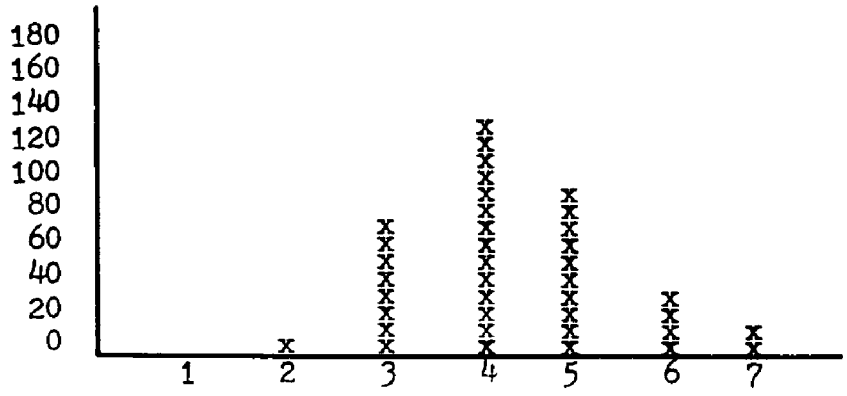
Histogram 9--Research Funds or Opportunities



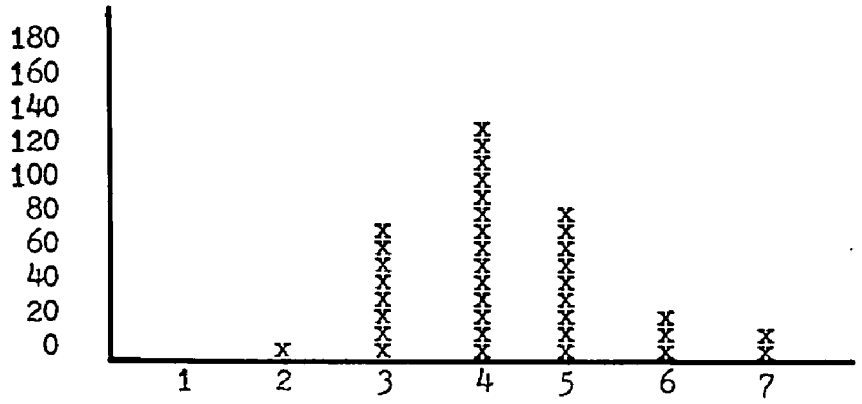
Histogram 10--Climate or Geography



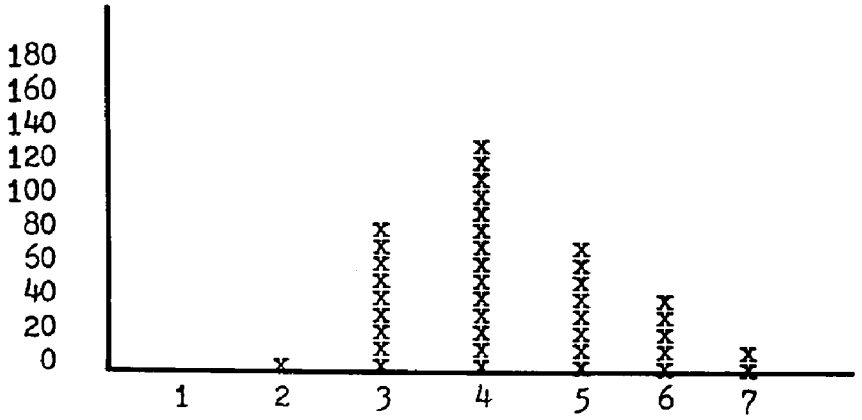
Histogram 11--Faculty-Chairman Relationship



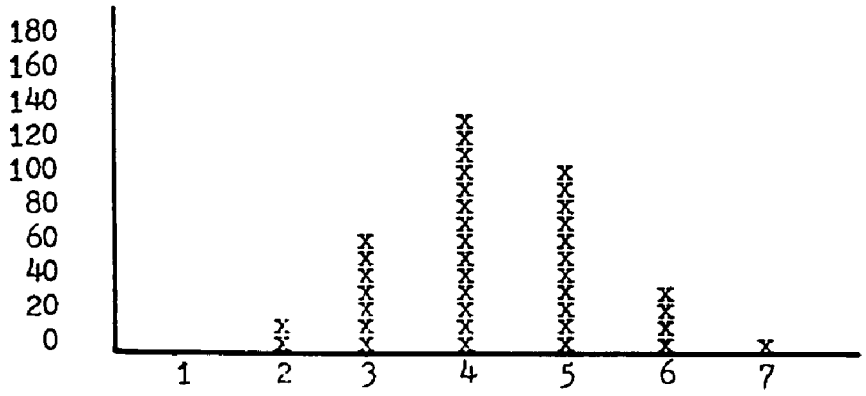
Histogram 12--Advancement Prospects



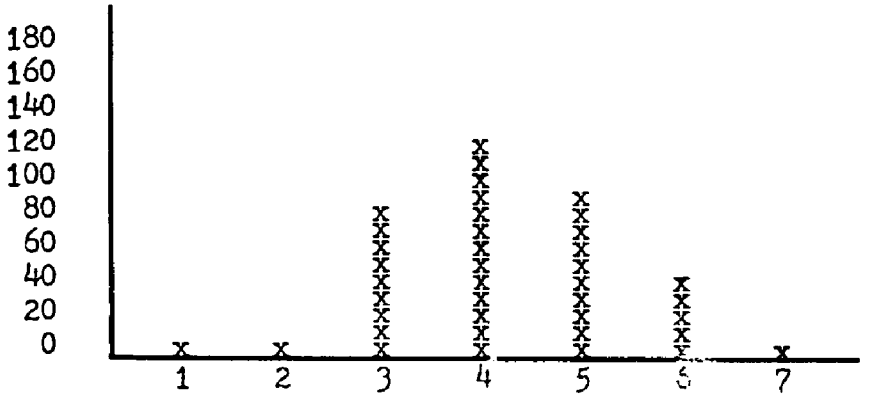
Histogram 13--Future Salary Prospects



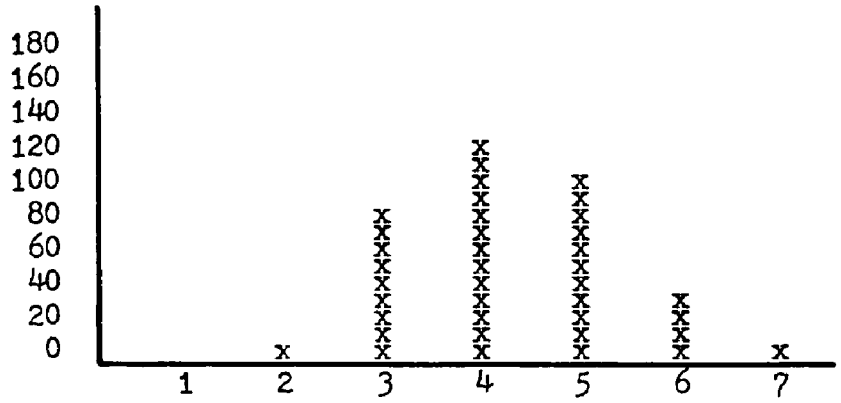
Histogram 14--Quality of Students



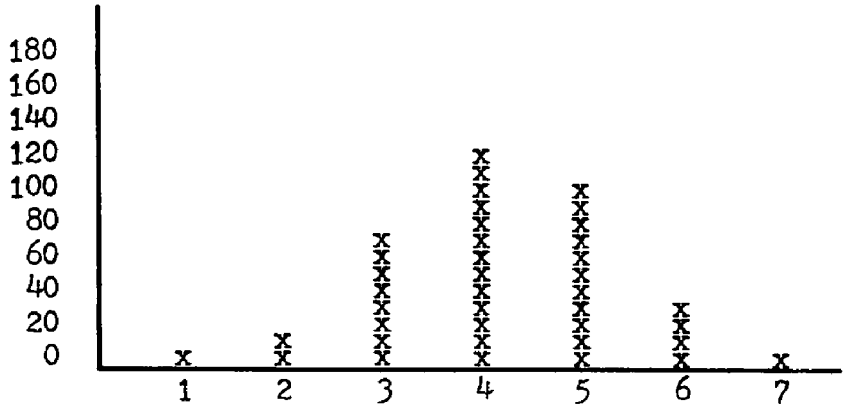
Histogram 15--Level of Teaching Assignment



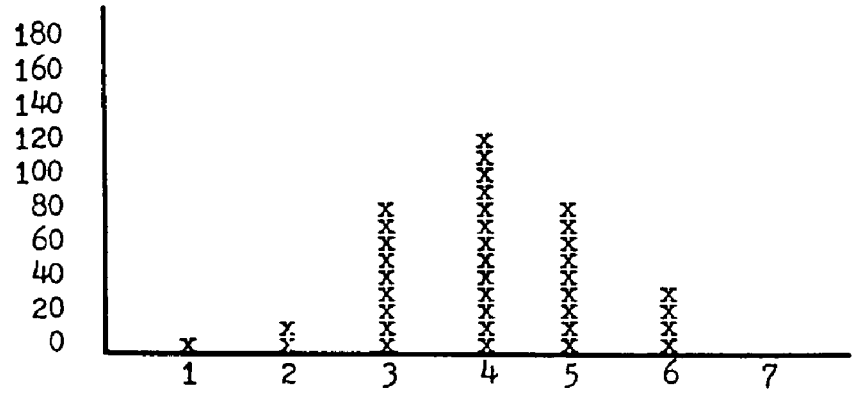
Histogram 16--Contact Hours of Teaching



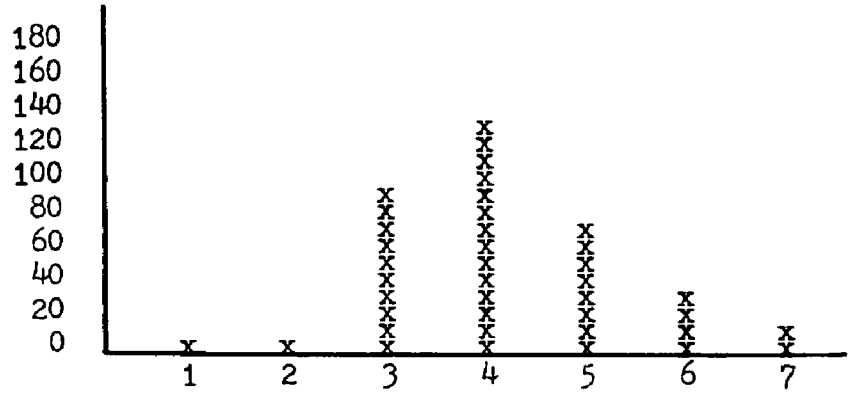
Histogram 17--Faculty-Student Relationship



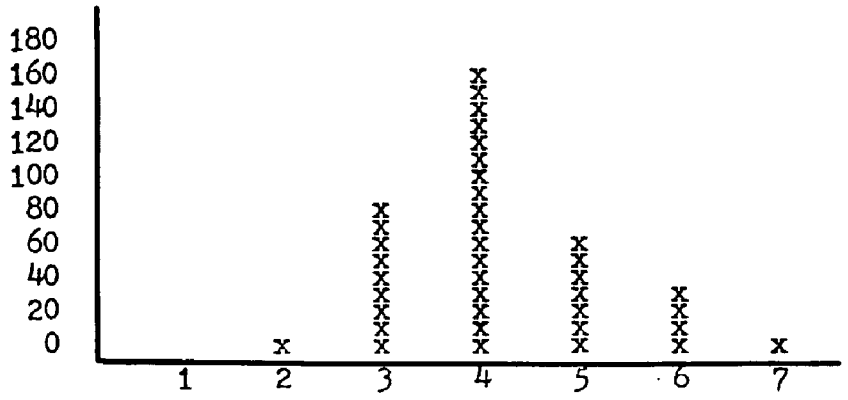
Histogram 18--Personal or Family Preference



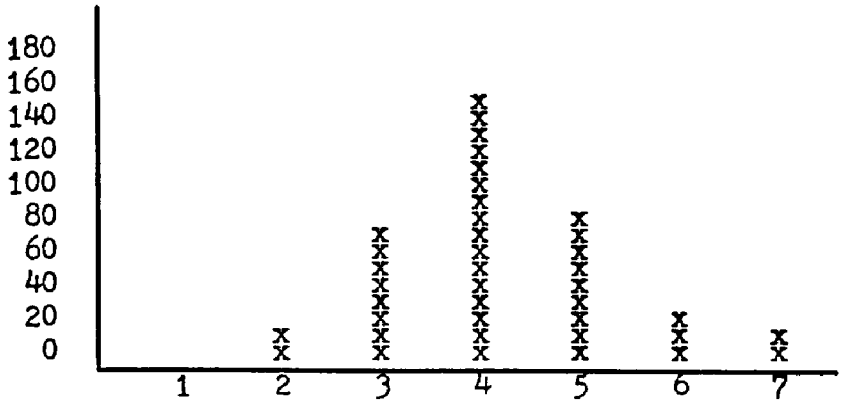
Histogram 19--Physical Facilities for Research



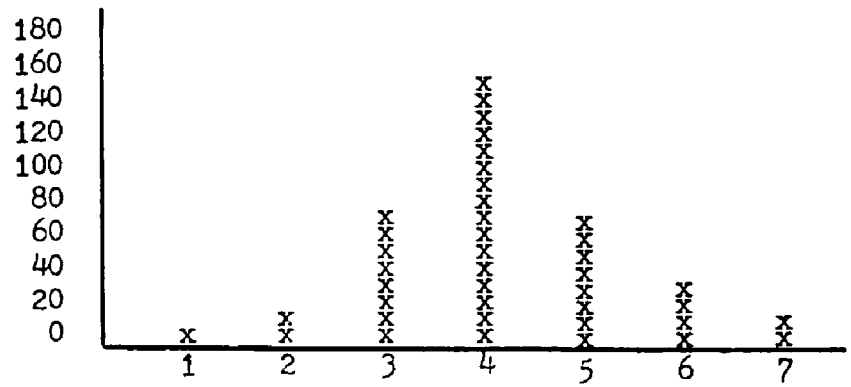
Histogram 20--Faculty-Administration Relations



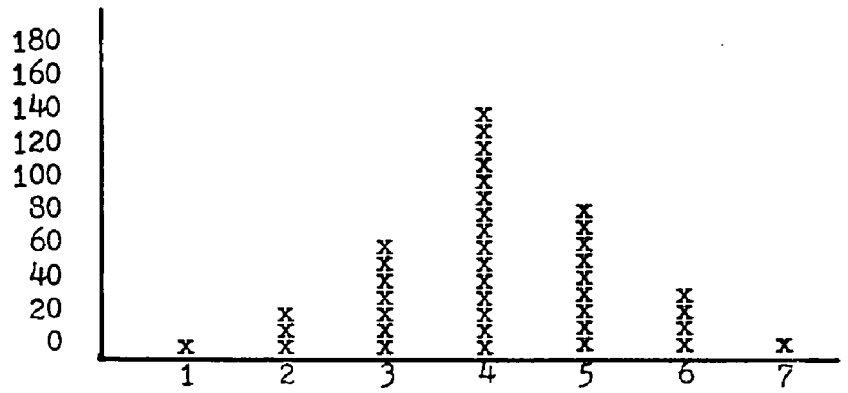
Histogram 21--Academic Rank



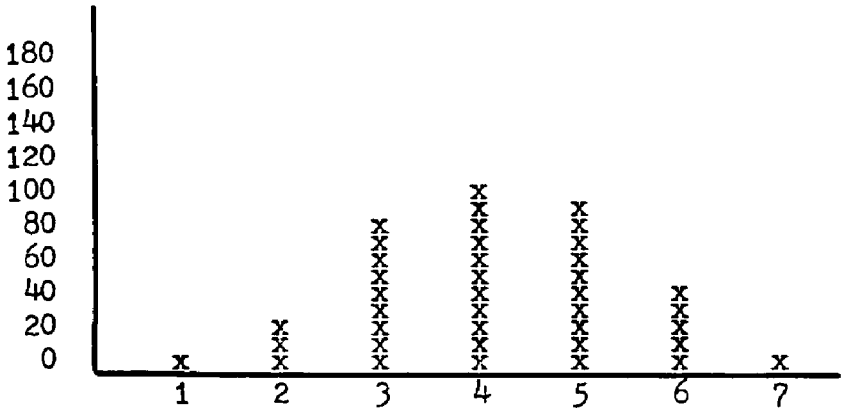
Histogram 22--Promotion and Tenure Policies



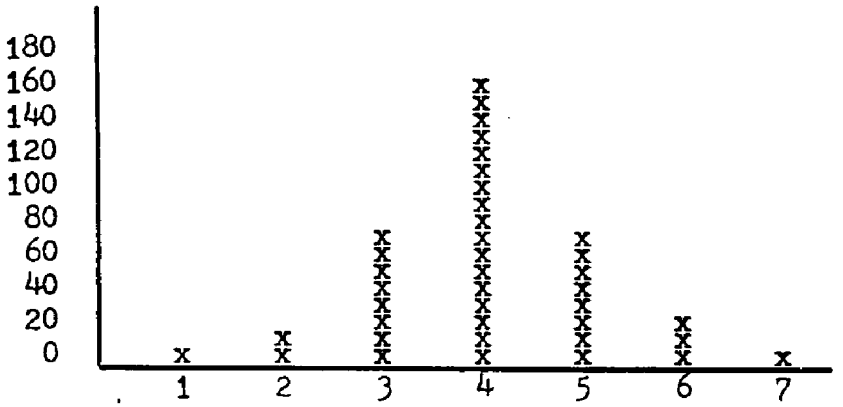
Histogram 23--Prestige of Department



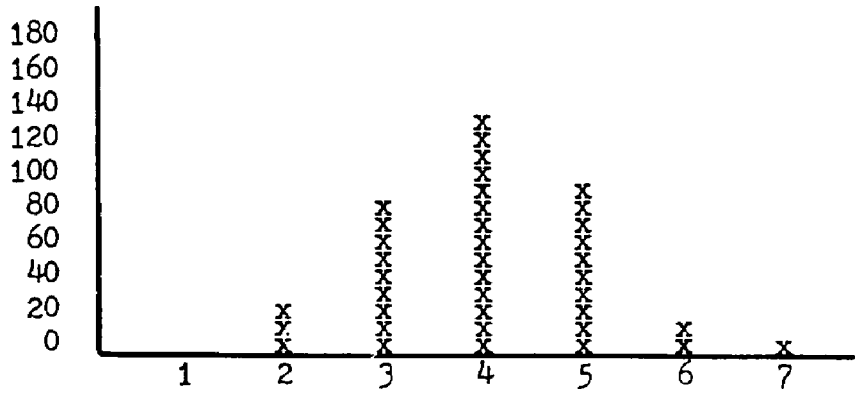
Histogram 24--Cultural Aspects of Community



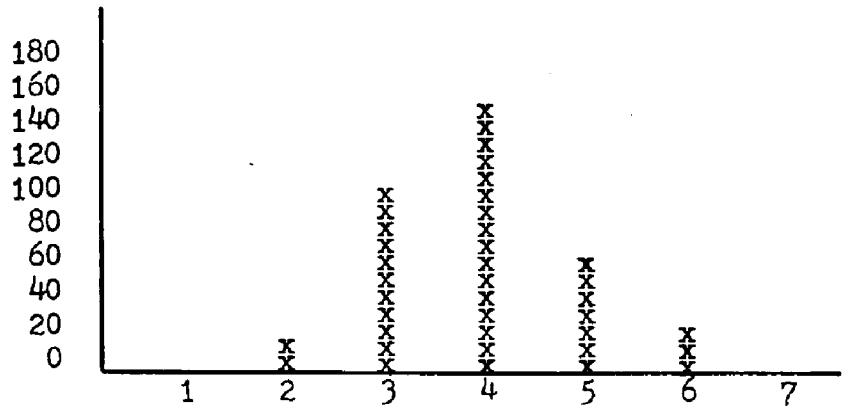
Histogram 25--Emphasis on Research



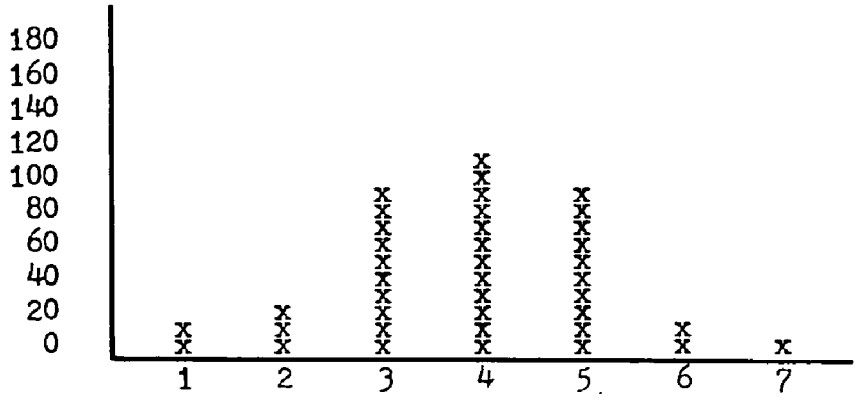
Histogram 26--Prestige of Institution



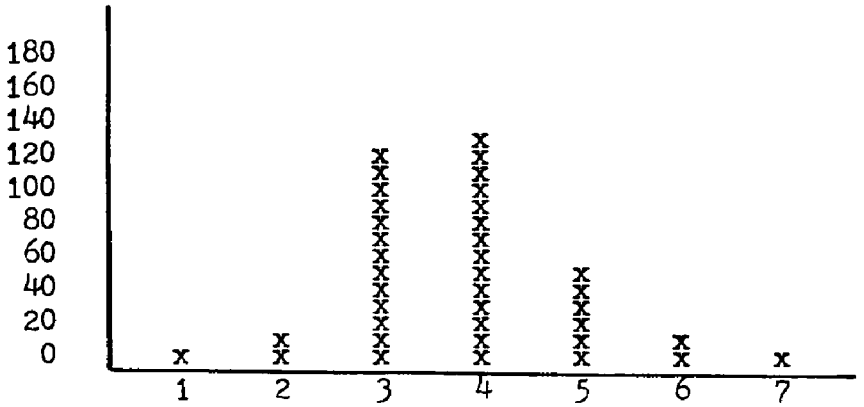
Histogram 27--Educational Aspects of Community



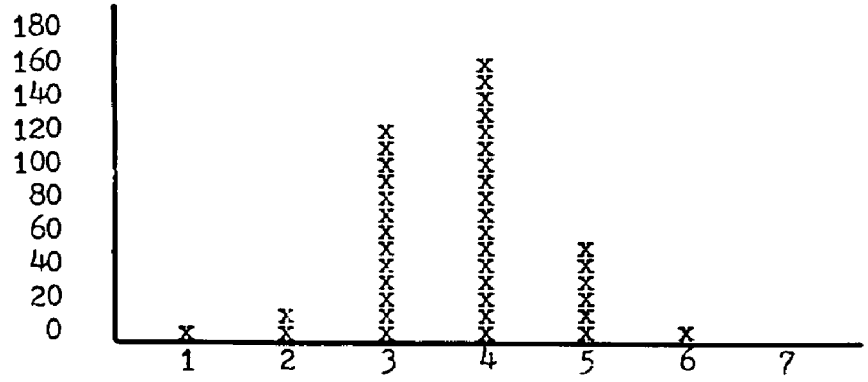
Histogram 28--Physical Facilities for Teaching



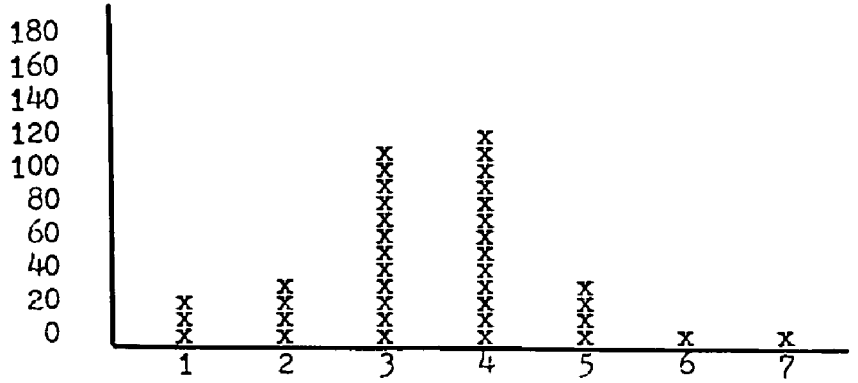
Histogram 29--Recreational Aspects of Community



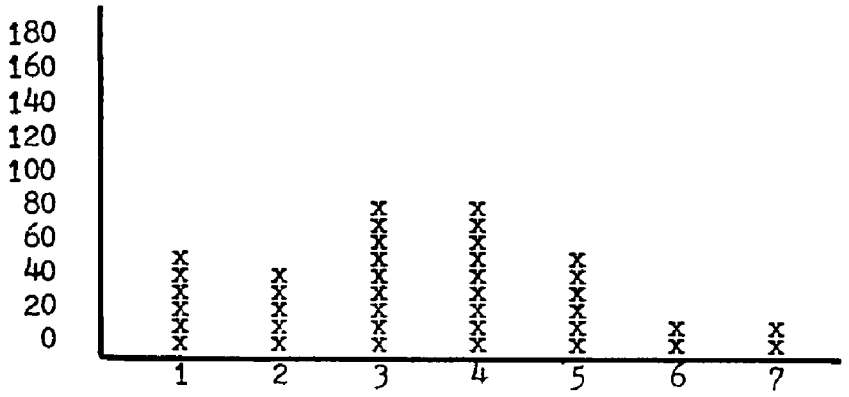
Histogram 30--Faculty Role in Policy Making



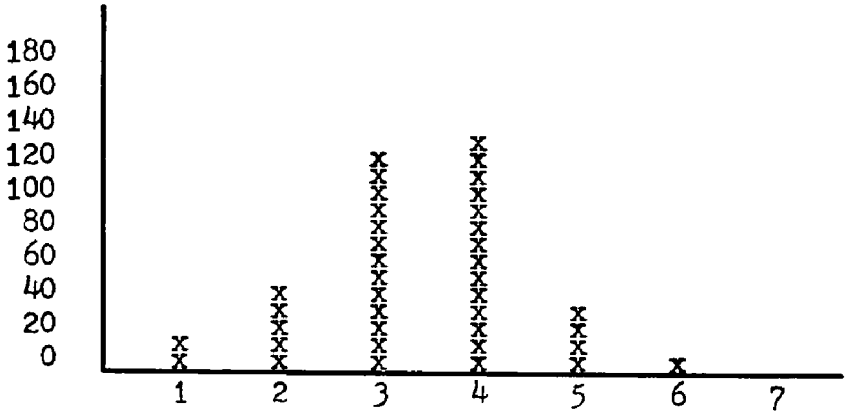
Histogram 31--Library Holdings and Services



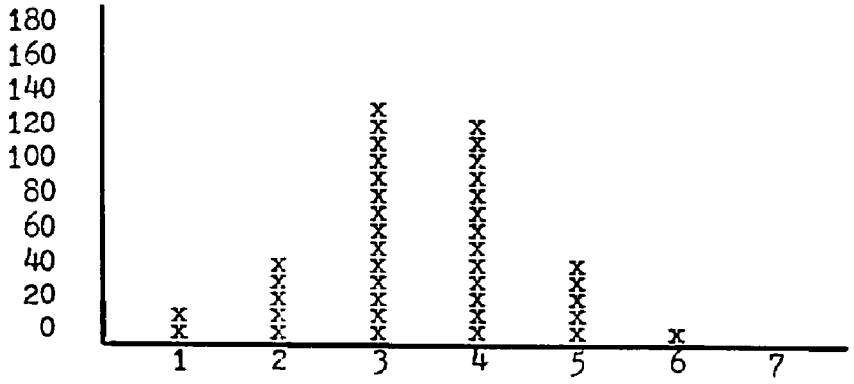
Histogram 32--Reputation of a Faculty Member



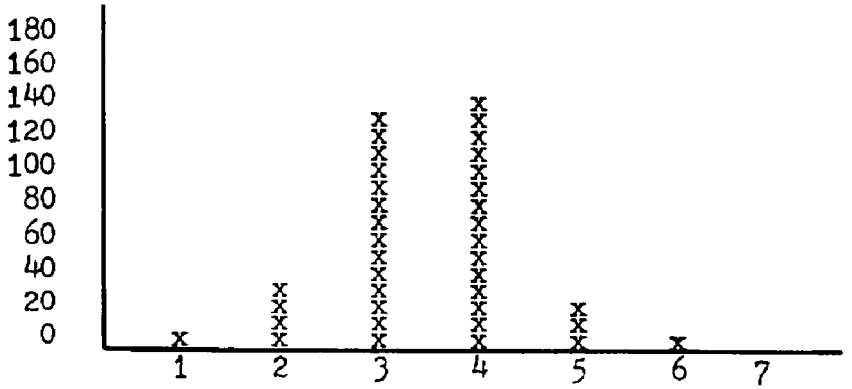
Histogram 33--Nearness to Friends or Relatives



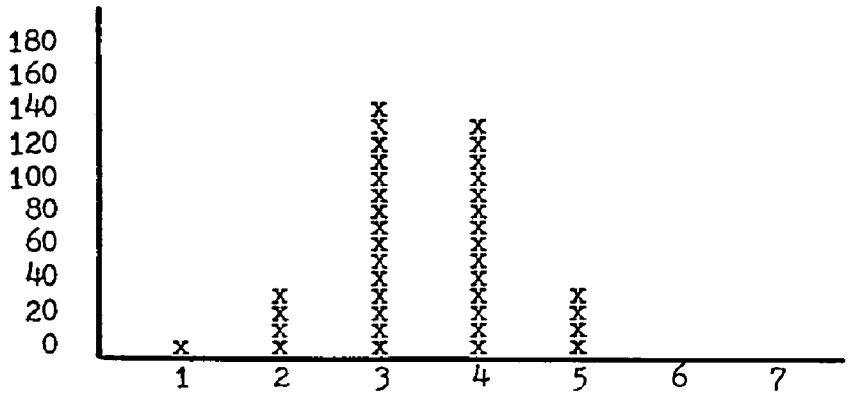
Histogram 34--Cost of Living in Community



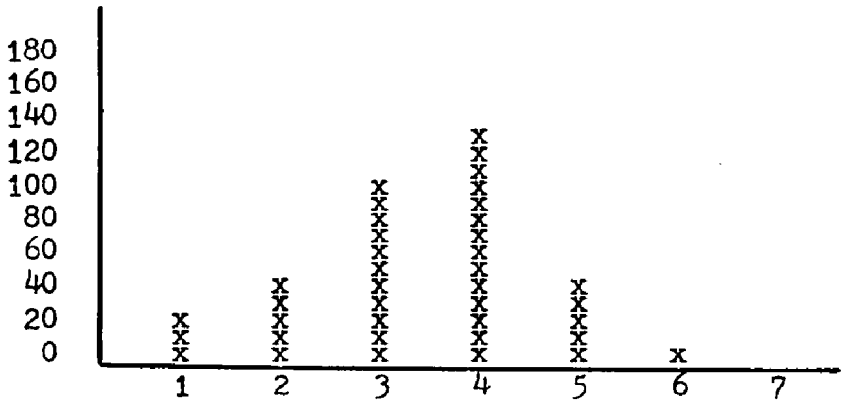
Histogram 35--Expenses Paid to Meetings



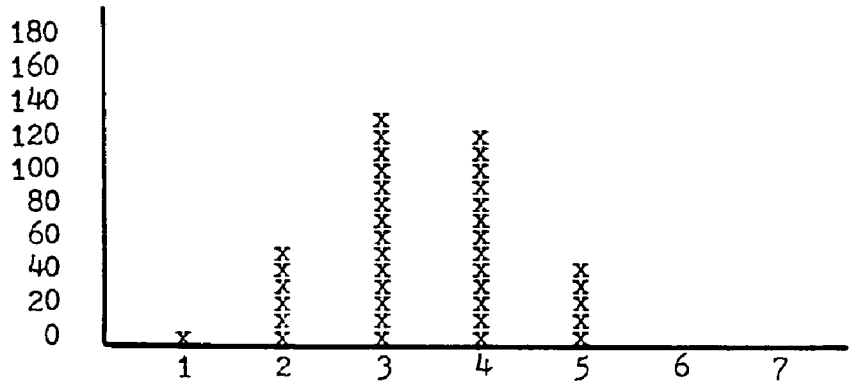
Histogram 36--Financial Fringe Benefits



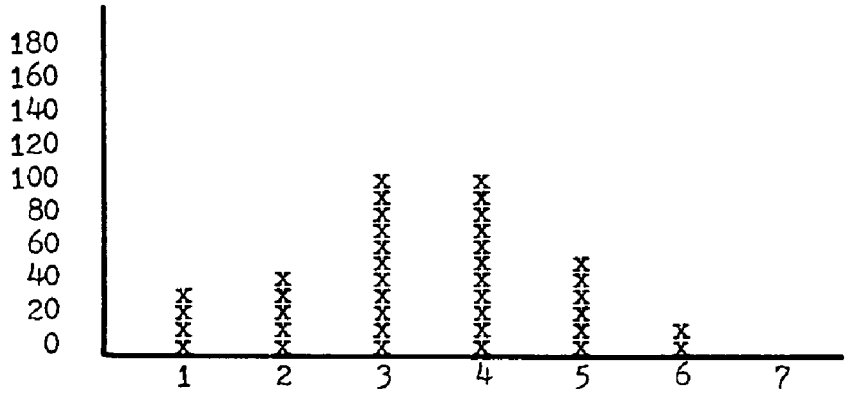
Histogram 37--Secretarial-Technical Aides



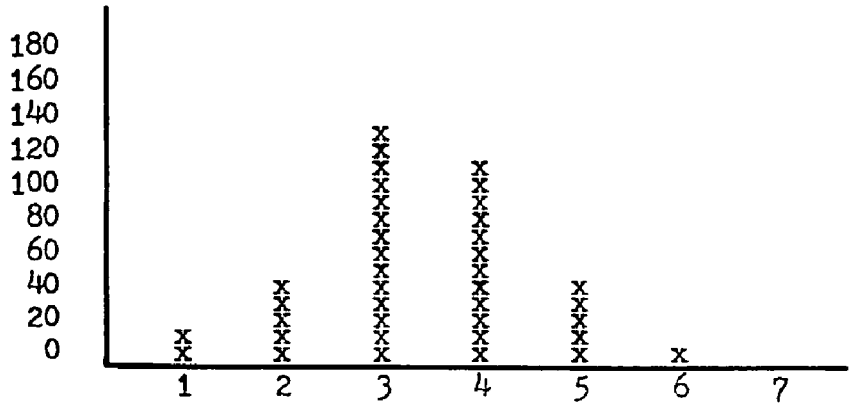
Histogram 38--Retirement Plan



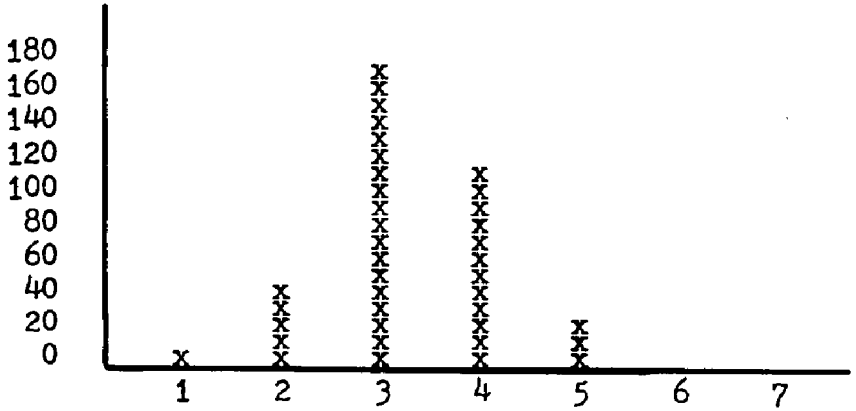
Histogram 39--Office Space



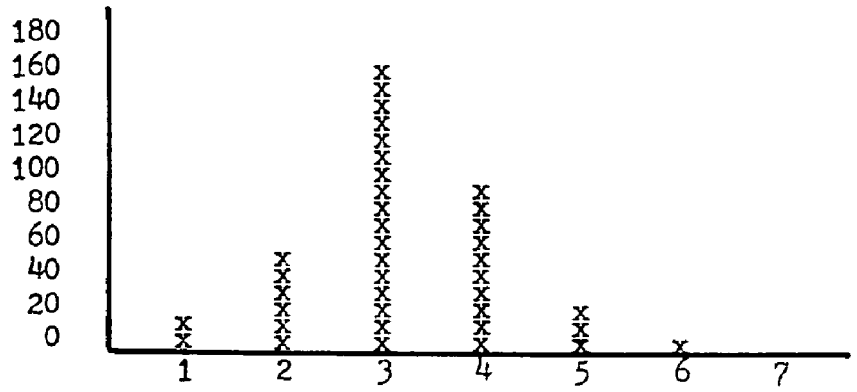
Histogram 40--Commuting and/or parking



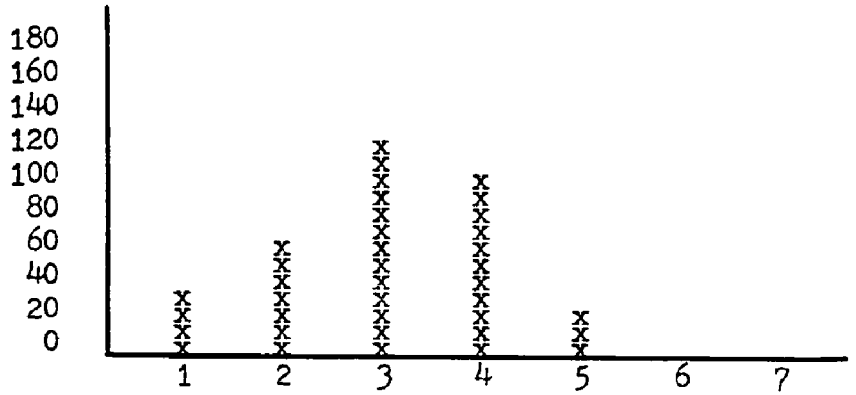
Histogram 41--Research Assistants



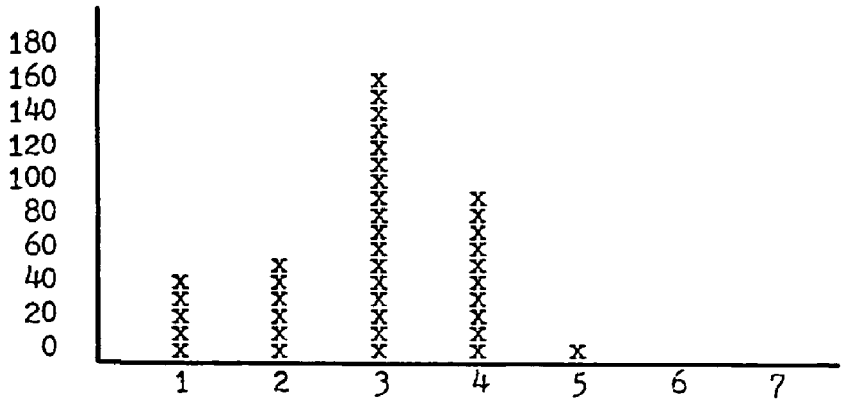
Histogram 42--Teaching Assistants



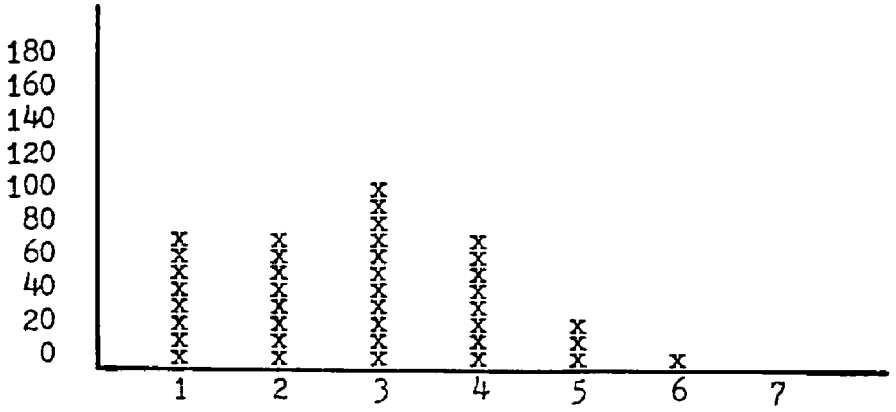
Histogram 43--Non-financial Fringe Benefits



Histogram 44--Financial Aid for Publication



Histogram 45--Committee or Extra Activites



Histogram 46--Consulting-Extra Income Prospects

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