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THE ENGINEERING TECHNICIAN: DILEMMAS OF A MARGINAL OCCUPATION

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ABSTRACT

The engineering technician occupies a position in the occupational hierarchy intermediate between that of the engineer and that of the craftsman. His ambivalence regarding his status and the ambivalence of others towards him contribute to his marginal position. The marginality of the engineering technician is also reflected in the heterogeneous nature of his work, the multiplicity of titles used to designate his work, his education and training, the rate and method of compensation, his self-image and the public images of his occupation. Various adaptations to the built-in role strains of his occupation are analyzed.

The ratio of engineering technicians to engineers is markedly lower in the United States than it is in Great Britain, France, the Soviet Union, and West Germany. The cultural values placed on achievement and the college-centered character of the American educational system contribute to this shortage. The recruitment of women into this occupation may relieve the shortage. Pressures for professionalization of engineering technicians, generated by on-going technological changes, may reduce the marginality of this occupation.

THE ENGINEERING TECHNICIAN:

DILEMMAS OF A MARGINAL OCCUPATION*

The emergence of new occupations and the decline of old occupations are continuing processes in an industrial society. Stimulated by economic or political developments, or both, the ceaseless process of technological change brings new occupations into being and makes others obsolete. In aggregate and dispassionate terms, the decennial census in the United States records the birth and death of occupations as well as of human beings.

An illustration of the relentless process of occupational and industrial change is the development of the electronic computer after World War II. The rise of the computer industry, producing thousands of different types of computers, called into being a complex of new occupations, including that of the "computer programmer". Simultaneously, it eliminated the need for clerks previously performing, manually or mechanically, some of the operations of the computer. Neither the first edition of the Dictionary of Occupational Titles (DOT) in 1939 which listed over 17,000 occupations, nor the second edition (United States Employment Service, p. xi) with over 22,000 listings, has an entry for a "computer programmer". Undoubtedly, the third and completely revised edition of the DOT to be published in 1963--with as many as 6,000 new jobs added--will officially record the birth of this occupation (Eckerson, 1963, p. 19).

Another occupation that does not appear in either of the editions of the DOT is that of the "engineering technician."[1]

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[1] In a recent supplement to the second edition of the Dictionary of Occupational Titles a new three-digit code has been established for engineering technicians. See United States Employment Service, Technical Occupations in Research, Design, and Development (Washington, D.C.: U.S. Government Printing Office, 1961, pp. 97-100.

For several decades, the Census has probably classified engineering technicians in the miscellaneous category of "technicians not elsewhere classified". Unlike medical and dental technicians, engineering technicians are comparative newcomers to indstry and government (Williford, 1957, p. 436; Wolfbein, 1954, pp. 52-55; Smith, 1962, pp. 123-124).

Along with the increasing magnitude of resources devoted to research and development, the increasing complexity of technology, and the growth in the number of scientists and engineers, the number of engineering technicians has increased steadily. In fact, during the 1950's, this occupation increased more than twofold--from 112,000 to approximately 275,000--which makes it one of the fastest growing occupations (Rutzick and Swerdloff, 1962, p. 1210; Deutsch, 1963, p. 17). In spite of the rapid growth of this occupation, the supply has not kept up with the demand (Ford Foundation, 1962, p. 14; President's Science Advisory Committee, 1962, pp. 23-24; Engineering and Scientific Manpower Newsletter, 1962, p. 1), nor has the increase in the number of technicians kept pace with the increase in the number of scientists and engineers (Brady et al., 1959, p. 8). In the opinion of Werwath, a member of the President's Committee on Scientists and Engineers, "it is safe to say that the shortage of technicians is even more severe...than the shortage of engineers" (Werwath, 1958, p. 88). Although this manpower problem is not unique to the United States, it is not as acute, as we shall see, in some of the other industrial societies (McCrensky, 1958, p. 156; Silk, 1960, p. 108; Korol, 1957, pp. 109-110).

In research and development organizations as well as in manufacturing organizations, the engineering technician has received scant attention by social scientists. In contrast, scientists and engineers have been the

subject of several social science investigations (Marcson, 1960, Kornhauser, 1962; Strauss and Rainwater, 1962). In terms of the occupational hierarchy, the engineering technician occupies a position intermediate between that of the engineer and that of the craftsman or skilled production worker. This position on the occupational ladder and the ambivalent orientations stemming from it tend to make the engineering technician a "marginal man". As in the case of all marginal men, the strains he experiences are mainly social in origin. The major problem facing the engineering technician is the clarification of his occupational identity: he seems to be searching for answers to the questions, "Who am I? and "Who is he?".

The purpose of this paper is to explore some dimensions of the occupational marginality of the engineering technician, the nature of his occupational relationships, his relative status profile, his adaptations to role strains, and the sources of some noteworthy national differences in the status of this occupation.

CONCEPT OF OCCUPATIONAL MARGINALITY

Before we consider the respects in which the engineering technician is a marginal man, the very concept of marginality bears some consideration. As first introduced in sociological literature by Robert E. Park (1928, pp. 881-893), and further developed by Stonequist (1937), it referred to a status interstitial between two cultures, whether racial, ethnic, or religious in character. A marginal man is an "individual who through migration, education, marriage, or some other influence leaves one social group or culture without making a satisfactory adjustment to another and

finds himself on the margin of each but a member of neither."[2] An example of a marginal man is a recent immigrant to the United States, who by virtue of having left his mother country has loosened, if not severed, his ties with his country of origin, and, at the same time, has not yet become integrated into the culture of the United States. He is a "cultural hybird" and suffers from anomie, that is, a lack of social bonds and commitments to the norms of a group or a society.

The concept of the "marginal man" has since been applied, by several social scientists, to the analysis of occupational roles. Wardwell (1952), in his study of the chiropractor, argues persuasively that occupational marginality need not necessarily involve an intermediate position between two different roles, groups, or cultures; "...there can be marginality to a single well-defined social role.... A marginal role is an imperfectly institutionalized one, which means that there is some ambiguity in the pattern of behavior legitimately expected of a person filling the role..." (p. 340). The chiropractor is not torn between wanting to be a physician or, say, a businessman; and he surely is not uncertain as to whether he wants to be a physician or a quack. His role is marginal to the well-institutionalized role of the physician. In other words, marginality may also be used with reference to one role, group, or culture.

There are, to be sure, instances of occupational marginality involving marginality to two roles, groups, or cultures. McCormack (1956, pp. 308-315), in a study of the druggist, conceptualizes this occupation as one involving a dual - rather than a single-group marginality. The druggist is torn between his commitment to pharmacy as a profession, which involves an orientation of service to clients, and his commitment to pharmacy as a

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[2]This is evidently a paraphrase of Park's concept of the marginal man by Delbert C. Miller and William H. Form, Industrial Sociology (New York: Harper & Bros., 1951), p. 631.

business enterprise, which involves an orientation of maximizing profit from his transactions with his customers. Students of industrial organization have analyzed the conflicting or ambiguous expectations of foremen in terms of the concept of the "marginal man" (Gardiner and Whyte, 1945, pp. 1-28; Roethlisberger, 1945, pp. 283-298; Wray, 1949, pp. 298-301). As the lowest man on the managerial ladder, with meager authority and reward, his identification with management tends to be weak; at the same time, he is not likely to develop a strong identification with rank-and-file subordinates who tend to define his role as a representative of management. Similarily, Shepard, in an analysis of occupational marginality of the engineer, conceptualizes the engineer's role as one that borders on the position of the scientists on the one hand, and on the position of the business executive on the other. The engineer, in his preoccupation with design, development, or production problems, is concerned with applying an existing body of knowledge to a useful and technically proficient product. Thus, he appears to be alienated from the culture of the scientist which emphasizes the value of contributing to scientific knowledge; similarly, he finds the economic values of the business executive somewhat foreign to him. Hence, he feels marginal to both occupational groups and they, in turn, tend to reciprocate this feeling of alienation. The scientist tends to scorn him as a "nuts and bolts" man who does not appreciate the meaning of science; and the executive tends to be critical of him as an impractical man oblivious to cost or market considerations in his work (Shepard, 1957, pp. 536-542).

The dual- and single-group meanings of marginality are both useful ways of conceptualizing occupational marginality. In our analysis of some features of the engineering-technician occupation, we shall alternate, as

the data dictate, between a single- and dual-group concept of marginality. Another facet of marginality related to the single-group concept that will inform our treatment of the engineering technician is Merton's (1957, pp. 290-291). observation that a marginal man is one who aspires to membership in a group which denies him admission. This is a central problem of reference group theory: the attitudes of non-members--whether eligible or ineligible--toward membership in a particular group (Merton, 1957, pp. 290-291).

The engineering technician is a marginal man in that his occupational life-space is bounded by the engineer on one side, and by the craftsman or skilled worker on the other, and he himself may have ambivalent feelings with regard to either or both of these occupations.

DIMENSIONS OF MARGINALITY

The marginality of the engineering-technician role is reflected in different facets of the structure of the occupation. In considering several features of this occupation, we shall observe three characteristic attributes: uncertainty, heterogeneity, and ambiguity.

Nature of Work. The diversity of functions of the engineering technician is reflected in the multitude of definitions of this occupation. One definition, developed by a committee of the American Society for Engineering Education, illustrates the heterogeneous nature of his tasks:

> "In general, the engineering technician is a person whose interests and activities are directed chiefly toward the testing and development, the application, and the operation of engineering or scientific equipment or processes....Classified occupationally, the engineering technician performs semi-professional functions of an engineering or scientific nature, largely upon his own initiative and under only general supervision of a professional engineer or scientist.

> "Typical among the wide array of semi-professional functions performed by engineering and scientific technicians are: Drafting, design, and development of products and of engineering plant; testing, installing, inspecting, operating, and maintaining engineering or scientific equipment; and estimating costs, selling and advising customers on the use of engineering or scientific equipment.
>
> "In many instances, the technician may serve as a liaison between the engineer or scientist on the one hand, and the skilled craftsman or layman on the other hand. In carrying out these various activities, he may have group leadership responsibilities. The technician must be able to communicate mathematically, scientifically, and linquistically." (Werwath, 1958, p. 880).

A summary characterization of the difference between the engineer and the engineering technician reads as follows:

> "The technician...possesses skills which the professional does not usually have. The hallmark of the technician, especially at the higher levels, is his unique blend of some professional knowledge and manual or instrumental skill." (Wolfbein, 1954, p. 50).

The wide array of functions and qualifications enumerated above suggests that the engineering technician may vacillate between feeling omnicompetent and incompetent--as good as the engineer, if not better, or merely a "handmaiden" to the engineer. The fact that he is currently doing work which engineers were doing 20 or 25 years ago (Smith, 1962, p. 124; Williamson, 1952, p. 33) and may, in some instances, be doing work indistinquishable from that of present-day engineers (Brady et al., 1959, p. 4) hardly contributes to the development of a clear conception of his occupational identity (Becker and Carper, 1956, pp. 341-348). No wonder there are differences of opinion not only in regard to the nature of his work, but also in regard to the worthwhileness of his contribution. For example,

> "Some regard them as 'supporting personnel', others consider them as specialists versed in some particular phase of an art or science but lacking, or not being expected to generate, creative thinking with regard to it." (Brown, 1957, p. 18)

A staff report by the American Institute of Physics (1963, p. 50) extols the contribution of the technician in the following terms:

> "Behind the experimental physicist in the record of accomplishment in physics stand the instrument maker, the electronics technician, and the machinist...often unsung, but not unappreciated in the physcis department. One thinks of A.A. Michelson and his instrument maker Fred Pearson, of R.A. Millikan and Thomas O'Donnell, and of Lord Kelvin and C. F. Varley. Physicists are well aware of the truth of Francis Bacon's remark... 'The unassisted hand and the imagination left to itself possess little power'...."

In sharp contrast to this warm praise is the following statement emphasizing the general incompetence of technicians in a research setting:

> "Instruments and technicians may, I suggest, reduce seriously the creativeness and originality of the young investigator. Before he has had the experience of being a naturalist, a man with his butterfly net, he is cast into a world consisting of a laboratory full of modern apparatus and two technicians who know how to do reliably almost nothing." (Page, 1963, p. 451).

Occupational Title. The heterogeneity of the work of the engineering technician is also evident in the bewildering array of titles used to characterize his position. A study of more than 1,000 graduates of the technical-institute program of Pennsylvania State University, classes of 1955-61 (1962, pp. 1-4), reported over 377 different titles to designate their work (Smith and Lipsett, 1956, pp. 80-90). Among the most common titles listed were: design draftsman, electronic technician, laboratory technician, electrical technician, engineering aide, and technical aide.

Such diversity of nomenclature hardly contributes to the development of a coherent occupational identity:

> "Kinds of work tend to be named, to become well-defined occupations, and an important part of a person's work-based identity grows out of his relationship to his occupational title. These names carry a great deal of symbolic meaning, which tends to be incorporated into the identity. In the first place, they specify an area of endeavor belonging to those bearing the name and locate this area in relation to similar kinds of activity in a broader field. Secondly, they imply a great deal

about the characteristics of their bearers, and these meanings are often systematized into elaborate ideaologies which itemize the qualities, interests, and capabilities of those so identified." (Becker and Carper, 1956, p. 342).

Two researchers on institutes training technicians conclude that technicians are "handicapped by the lack of uniform titles and credentials which...clearly identify their educational background." (Smith and Lipsett, 1956, p. 100).

Education and Training. The body of skills and knowledge expected of an engineering technician is also ambiguous, in part, because of the variety of educational and vocational routes to membership in this occupation. The majority of technicians have probably obtained their training in an Armed Forces technical school or in an on-the-job training program in industry.[3] A small proportion of technicians may have received some formal education in an evening extension course at a university or through a correspondence course. Probably a minority of the 275,000 engineering technicians have attended a two-year technical institute or junior college.

A survey covering 517 industrial and government organizations employing 287,630 engineers, physical scientists, and engineering technicians, found that approximately 25 per cent of the technicians were graduates of a technical institute (Engineering Manpower Commission, 1962, Table VII, p. 49). The quality of these schools varies greatly. Only 38 institutes out of a total of 202 reporting to the U.S. Department of Health, Education and Welfare are accredited by the Engineer's Council for Professional Development (Brady et al., 1959, p. 21). Moreover, technical-institute education differs in content and purpose from that of the vocational school on the one hand, and from that of the engineering college on the other. As a post-secondary

[3]For some relevant data based on interviews with only 15 technicians see James T. Brady et al., Teamwork in Technology: Managing Technician Manpower (New York: Technician Manpower Associates, 1959), pp. 71-72.

institution of two years' duration, the technical institute emphasizes in its curriculum "the understanding and practical application of basic principles of mathematics and science as they relate to a major technical specialty, rather than the acquisition of proficiency in manual skills." (Brady et al., 1959, p. 15).

The diversity in type and quality of training probably affects the type of occupational self-conceptions developed as well as the type of career aspirations. In the absence of systematic research on this issue, we may conjecture that engineering technicians with a formal education and an Associate degree in engineering from a technical institute, will develop hopes for achieving the status of an engineer. A study of students at Wentworth Institute suggests that this may be true at least for students at superior technical institutes. This survey found that 65 percent of the students thought of themselves as "junior engineers" and 84 per cent expected to earn the title of "engineer" during their careers (Brady et al., 1959, pp. 112, 114). These students may later experience their marginality in that they may perceive their occupation as a transient one and as a stepping-stone to the loftier goal of a career in engineering. To the extent that those with formal training and a technician's degree encounter obstacles to the realization of their career goals, their role strains will probably be considerably greater than those of technicians who have had a relatively informal type of training and who have probably developed different career aspirations.

Rate and Method of Compensation. The shortage of technicians is, in part, reflected in the amount of resources expended by industry in recruiting technicians. The cost of recruiting an engineering technician is almost the equivalent of that of recruiting an engineer. Hence it is not surprising to discover that there is an overlap in the reward structure of the engineering

technician with that of the engineer. The beginning technician's salary may be approximately at the half-way mark on the compensation scale of the skilled worker; and the engineer's beginning salary may be equal to the median salary of the technician (Brady et al., 1959, pp. 46-52). "Sometimes an experienced technician will be paid as much as or more than recently hired engineers, while in other cases, a highly skilled production worker can earn more than a lower level technician." (Brady et al., 1959, p. 50). This overlap in reward structure probably engenders some awareness as to the relative standing, prospects, and worthwhileness of the respective occupations. It may encourage some technicians to aspire to the level of reward of the engineer.

Another confusing feature of the system of rewards for engineering technicians is that some employers--approximately three-quarters according to one study (Brady et al., 1959, p. 50)--compensate them on an hourly basis while others do so on a monthly basis. In other words, some employers choose to treat them like hourly-rated production workers, and others like salaried engineers and scientists. This again underscores the ambiguity of their location in the occupation hierarchy.

Self-Image and Public Image. Given the heterogeneous nature of the work of engineering technicians, the multiplicity of occupational titles, the varied training and reward structures, we would expect them--as we have suggested above--to differ appreciably in their self-image. Some engineering technicians may be quite uncertain as to how they differ from the skilled worker or from the engineer, and are accordingly vague about their career goals. Others may be persuaded that they are more like production workers than engineers, and some may see themselves as "junior engineers" who will eventually become full-fledged engineers.

The managers of an industrial organization or of a government laboratory employing engineering technicians may have parallel images of members of

of this occupation. Some may look upon them as potential engineers, others as quasi-engineers with a body of knowledge and skills distinct from engineers, and still others as skilled workers (Brady et al., 1959, pp. 89-90). Obviously the fortunes of engineering technicians are, in part, dependent upon their own self-image and, in part, on the image formed by the managers of the organizations in which they are employed.

The public at large probably has a very nebulous idea of what an engineering technician does, what his career opportunities and aspirations are, and what his relationships are with other occupations. Merrit Williamson (1952, p. 32), Dean of the College of Engineering and Architecture of Pennsylvania State University, laments that, "The public does not know about the engineering technician and there seems to be little desire on the part of high school graudates to consider this work as a possible career." The Census term of "semi-profession" and the designation in some of the manpower literature of "sub-profession" to describe the occupation of the engineering technician highlight the ambiguity of this occupation role. The absence of systematic data on the self-image and public image of the engineering technician is all too evident. The relative frequency of different self-conceptions and public conceptions of the engineering technician, and the sources and consequences of these conceptions, are questions still awaiting research.

Given some of these marginal attributes of the engineering technician, how are they manifested in the course of his work-related social interactions?

OCCUPATIONAL RELATIONSHIPS

In the course of performing his job, the engineering technician enters into relationships with members of various occupations both inside and outside the work organization. This network of relationships comprises his

"role-set", which consists of the roles that the occupant of a given status has by virtue of occupying that status (Merton, 1957, pp. 368-384). The number of members in his role-set and the degree of occupational homogeneity among them may aggravate or alleviate the marginal characteristics of his occupation. If the engineering technician works in a production, installation, or maintenance setting, he will probably have a larger number of relationships with fellow-technicians or with production workers than with engineers or scientists. His interactions with production workers may yield a feeling of relative gratification because his job partakes of more white-collar characteristics than does the job of a production worker. On the other hand, if his role-set includes a preponderance of engineers and scientists, he may experience a feeling of relative deprivation because of the gap between his semi-professional status and the status of the engineer or the scientist. The latter case is probably more likely to occur in research and development organizations than in any other organizational setting.

If the last assertion is borne out empirically, then it has some implications for the frequently discussed question of the ratio of technicians to engineers (Engineering Manpower Commission, 1962, pp. 27-29; Beatty, 1958, pp. 24-25; Andrea, 1962). The principal concern of those engaged in discussions of this issue is to insure that there is an adequate supply of technicians in order to prevent the under-utilization of engineers. They have not considered the possible effect of increasing the technician/engineer ratio on the conceptions, motivations, and social relationships of the engineering technician. Does decreasing this ratio tend to increase the amount of technician-engineer relations and decrease the frequency of interactions among technicians? If this is true, does it have the effect of increasing feelings of relative deprivation? Does increasing this ratio have the effect of decreasing the volume

of interactions between technicians and engineers and of increasing the frequency of interactions among technicians? If the latter is true, does it have the effect of diminishing feelings of relative deprivation? The effect of an increase in the technician/engineer ratio on the role-set relations of the engineering technician--an empirical question worthy of research--is probably a function of a) the system of allocation of engineering technicians, and b) various social and socio-psychological attributes of the technician such as his age, training, and career aspirations.

There are at least two systems of allocating engineering technicians in industry: one is on a departmental or "pool" basis, and the other is on a task or "project" basis. The larger the organization, the more likely it is to use a departmental or pool system. Organizations having a pool system of allocation assign their technicians to projects in which the technician-foreman is the administrative superior of the technician and the engineer he is working with is responsible for technical matters. Under this system, the engineering technician has two superiors--a situation which may generate role conflict. In a project system of organization the technician is assigned to an engineer who is responsible for administrative as well as technical supervision (Petrou, 1958, pp. 26-30). The resulting proximity to the engineer in this situation may engender hopes in some engineering technicians of someday making the transition to engineer status.

In an organization that has a pool system of allocation, the technician who has had little formal training, who is in his late 30's, and who has a commitment to his occupational role, will probably have frequent interactions with his fellow-technicians which, in turn, will probably counteract feelings of marginality.

The social barriers in the relationship between the technician and the engineer are greater the more inequality there is in the relative status of

the two occupations. If the occupational hierarchy in a particular organization is akin to a caste-like structure, with the technician rarely making the transition to an engineering job classification, his perceived occupational marginality will probably be accentuated. The experience of the engineering technician as a member of a trade union in which the majority of the members are engineers bears this out. In the now-defunct federation of unions, Engineers and Scientists Association (ESA), the dispute which led to its demise revolved around the question of whether the member unions should admit engineering technicians or whether they should be exclusively professional in their membership. In 1957 ESA decided not to admit any other unions which included technicians. It permitted affiliates to keep their technician members but it deprived them of the right to vote on federation decisions. As a result of this decision some of the member units left the ESA and attempted to form a rival federation hospitable to engineering technicians, "The Engineers' and Scientists Guild". The consequent weakening of the ESA resulted in its eventual disintegration (National Society of Professional Engineers, 1961, pp. 61-70; Kornhauser, 1962, p. 111; American Engineer, 1961, p. 18).

A similar controversy arose in the organization called "The Council of Western Electric Professional Employees". The union alleged that management was adding technicians to the bargaining unit in order to dilute the power of the union and alienate engineers from it. Hence this organization insisted on an exclusively professional association of engineers, barring technicians from membership (Brady et al., 1959, p. 34; Shea, 1959, pp. 149-157; American Engineer, 1960, p. 18). Such organizational decisions tend to increase the social barriers between the two occupations.

The recent organizational innovation initiated by the National Society for Professional Engineers (NSPE) may unexpectedly have a similar effect.

In an effort to provide "recognition" to engineering technicians for their contribution to the "engineering team", NSPE has set up an "Institute for the Certification of Technicians" (1962). This, in effect, creates a separate organizational entity for technicians within the larger framework of this professional engineering association. Whether the engineering technician perceives this innovation as a "segregationist" move designed to block his mobility or as an "integrationist" move promoting his professionalization will probably be reflected in the extent to which he avails himself of the privilege of certification.

RELATIVE STATUS PROFILES

Another way of characterizing the marginality of engineering technicians is in terms of the concept of "status congruency" or "status consistency" and in the resulting types of "status profiles" (Benoit-Smullyan, 1944, pp. 151-161; Homans, 1962, pp. 91-102; Nagi, 1963, pp. 440-443). The occupants of a particular status, such as that of an engineering technician, may be ranked on a set of attributes, or "status factors" as Homans calls them (Homans, 1962, p. 95). If an engineering technician is consistently high in his rankings on a set of factors, he is obviously more satisfied than a technician whose status profile is consistently low or at the midpoint of the scales. However, if his status profile is inconsistent, with some rankings high, some low, and some in the middle, he tends to feel dissatisfied and is motivated to equilibrate his rankings at as high a level as possible on the various status dimensions.

In all likelihood, the status profiles of engineering technicians differ greatly. To facilitate a comparison between the relative status of the engineering technician and the engineer and the craftsman, we shall

construct two hypothetical status profiles. With reference to such status dimensions as knowledge, skill, salary, prestige, and opportunity for advancement in an organization, the engineering technician who has a degree from a technical institute and approximately ten years of experience, when compared with an engineer with a degree from an average engineering school and a similar number of years of experience, may have the following status profile:

STATUS FACTORS:	Knowledge	Skill	Salary	Prestige	Opportunity for Advancement
PROFILE OF ENGINEERING TECHNICIAN RELATIVE TO PROFILE OF ENGINEER:	Equal	Greater	Less	Less	Less

That the engineering technician is lower than the engineer on salary, prestige, and opportunity for advancement is evident; that he may be higher than the engineer on the skill dimension and equal on the knowledge dimension is not at all evident. His manipulative skills, whether in design, development, testing, assembly, installation or other kinds of work, are probably greater because they have either been the object of special training in a technical institute or he has had more opportunity than the engineer to cultivate and perfect them in his work. Whether or not the two are equal in technical knowledge is dependent on whether the type of engineer we have taken as a subject for a portrait of relative status profiles has kept up with the rapid pace of new knowledge in his field or has obsolesced (Evan, 1963, pp. 29-31). If he has obsolesced in his knowledge, there is a tendency for a convergence in the amount of knowledge between himself and the engineering technician. The likelihood of obsolescence of knowledge may be reflected in

the leveling of the salary curve of engineers with ten years of experience:

> "(T)he engineer appears to have lost by his tenth year of employment the salary advantage which he had at the start and which he held fairly well for the first 5 years after graduation... Further evidence indicating that engineers are not as highly paid after 10 years as are men with little scientific and technical training was found in a survey of graduates of New York University... 'Engineering graduates in the past decade have enjoyed an ever-widening advantage in starting salary. But during this same span of years, however, the gap closes rapidly, and after 10 years, graduates in business and liberal arts and science surpass the engineering graduates in average earning power'." (Endicott, 1959, p. 12).

Given a relative status profile such as we have speculatively drawn above, the engineering technician probably perceives his relative position in the organization as unjust. Under these circumstances, if the organization blocks his mobility aspirations he probably perceives this as a threat to his status. This is very likely to occur in an organization where the policy is "once a technician always a technician". (Williford, 1957, p. 437).

In relation to the skilled worker or craftsman, the engineering technician's status profile on the same five dimensions may be as follows:

STATUS FACTORS:	Knowledge	Skill	Salary	Prestige	Opportunity for Advancement
PROFILE OF ENGINEERING TECHNICIAN RELATIVE TO PROFILE OF CRAFTSMAN:	Greater	Less	Greater	Greater	Equal

Is the relative gratification he may feel when he compares himself with the skilled worker sufficient to compensate for the relative deprivation he may experience vis-à-vis the engineer? In all likelihood it is not, unless he relinquishes the engineering occupation as a reference group. If he should relinquish this reference group he would eliminate the major source of his marginality.

ADAPTATIONS TO ROLE STRAINS

On the assumption that human beings seek to reduce tensions--a postulate of several social science theories,[4] e.g., the theory of cognitive dissonance--how does the engineering technician adapt himself to the built-in role strains (Evan, 1962, pp. 346-354) of his occupation? If he does not, in fact, relinquish the engineering occupation as a reference group in favor of a craft, there are at least several modes of adaptation open to him.

First, he may engage in "job hopping" in the hope of eventually finding an employer who will give him an opportunity to become an engineer despite the fact that he does not have a baccalaureate degree in engineering. Since a substantial proportion of those reporting themselves to Census enumerators as engineers do not have an engineering degree, this course of action may not prove to be futile (Brady et al., 1959, p. 2). In some companies, labor turnover among engineering technicians which is generally higher than for engineers, reaches 25 percent (Brady et al., 1959, p. 40). A common reason given in exit interviews by engineering technicians for changing jobs is "lack of opportunities for advancement". In an unpublished study 65 per cent stated this was a significant factor in their decision to change jobs.

What proportion of engineering technicians, with or without a degree from a technical institute, succeed in becoming engineers in the course of their careers is a question about which relatively little is known (Smith and Lipsett, 1956, pp. 84-85).

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[4]See, for example, Roger Brown, "Models of Attitude Change," in Roger Brown, Eugene Galanter, Eckhard H. Hess and George Mandler, New Directions in Psychology (New York: Holt, Rinehart & Winston, 1962), pp. 3-85.

A second mode of adaptation to role strain--also via a process of search, though it may not entail leaving the present employer--is to find a setting yielding intrinsic work satisfaction and possibly offering other benefits such as "ultra-clean" laboratories and access to expensive and prestige-conferring equipment, which some employers restrict to engineers only.

A third and related adaptation, also the product of search behavior within the present work organization or elsewhere, is to find a situation that yields an equilibrated relative status profile. This would mean that the engineer with whom a technician is associated is uniformly higher on all significant status factors. When this occurs the engineering technician will probably tend to legitimize the occupational and organizationally-induced differences (Evan and Zelditch, 1961, pp. 882-893) and develop a cooperative and possibly symbiotic relationship with the engineer, rather than one involving conflict and resentment.

Yet another mode of adaptation entails collective rather than individual action. The engineering technician may join a union of technicians to improve working conditions, though he is unlikely thereby to succeed in equilibrating his relative status profile.

A fifth mode of adapatation to his occupational role strains may be via the transvaluation of work values. Instead of yearning for the prestige, autonomy, and monetary rewards that he hopes to derive from the status of an engineer, the technician may seek to realize other work values. One substitute work value is job security. If he obtains a job in a government laboratory or in a large prosperous industrial organization reputed to have a stable work force regardless of fluctuations in the business cycle, he may find that the benefits he derives from job security are a fair exchange for the work values he relinquishes. Another substitute work value is

managerial authority. By aspiring to a supervisory position, whether in relation to other technicians or in relation to other categories of employees, the engineering technician may succeed in achieving an equilibrated status profile relative to another occupational category. In a study of technicians who graduated from Rochester Institute of Technology between the years 1926 and 1952, it was found that 10 per cent were engaged in supervisory or managerial work (Smith and Lipsett, 1956, p. 84).

A sixth mode of adaptation involves a determined effort on the part of the technician to obtain an engineering degree, even if it means many long years of part-time evening courses. A relatively small proportion of engineering technicians find it economical or otherwise feasible to cope with their occupational marginality in this manner. About 14 per cent of the graduates of Wentworth Institute, class of 1961, are in the process of continuing their college education for an engineering degree (Personal Communication, 1962); 4 per cent of the 1962 graduates of the Pennsylvania State University's technical institute program have chosen this way of solving their occupational problems (Personal Communication, 1963); and 3 per cent of the graduates for the years 1947 through 1950 of ten New York State technical institutes and the Rochester Institute of Technology subsequently enrolled in a college (Smith and Lipsett, 1956, pp. 96-97).

These six types of adaptations to the role strains of engineering technicians are by no means exhaustive. Another and obvious alternative available to some young engineering technicians willing to take the risks involved is to leave their occupation for another one. For example, 6 per cent of the graduates of the Oregon Technical Institute, class of 1952, reported working in other occupations (Smith and Lipsett, 1959, pp. 96-97). Short of permanently abandoning their occupation, those who remain may engage in a number of search operations and experiment with various modes of

adaptation in an effort to reduce, if not eliminate, the tensions stemming from a high degree of status incongruency, i.e., an unequilibrated relative status profile.

NATIONAL DIFFERENCES

A brief comparison of the position of engineering technicians in different countries may be instructive from the viewpoint of problems of occupational marginality as well as from general technical manpower considerations.

Although it is risky to compare occupations across national boundaries because of the diversity of definitions employed,[5] it has been observed that there is a larger number of engineering technicians in Europe and in the Soviet Union than in the United States. In terms of technician/engineer ratios, which can be misleading because they may be computed for a company, an industry, or for the labor force as a whole, the overall ratio of technicians to engineers in the United States is approximately 0.32, whereas it is 1.74 in the Soviet Union, 2.42 in France, 2.53 in West Germany, and 4.20 in Great Britain (see Table I).

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[5]Cf. Howard Rosen, "Technicians in the Labor Force of Russia and America," 81 Monthly Labor Review (January, 1958), p. 1; Organization for European Economic Cooperation, Manpower Committee , "Survey on Technicians" (Mimeographed, March 27, 1961).

TABLE I

RATIOS OF ENGINEERING TECHNICIANS TO ENGINEERS IN FRANCE, GREAT BRITAIN, UNITED STATES, SOVIET UNION AND WEST GERMANY

Country	Reference Period	Number of Engineers in Total Labor Force	Number of Engineering Technicians in Total Labor Force	Ratio of Engineering Technicians to Engineers
France[a]	1954	140,000	340,000	2.42
Great Britain[b]	1959-60	100,800	Not available	4.20
United States[c]	1960	853,738	275,072	0.32
Soviet Union[d]	1960	1,236,000	2,157,000	1.74
West Germany[e]	1956	74,741	189,676	2.53

(a) SOURCE: Organization for European Economic Co-operation, The Problem of Scientific and Technical Manpower in Western Europe, Canada and the United States (Paris: Organization for European Economic Cooperation, 1957), p. 76.

(b) SOURCE: The number of engineers in the labor force of Great Britain is reported in Advisory Council on Scientific Policy, Committee on Scientific Manpower, Statistics Committee, The Long-Term Demand for Scientific Manpower, cmnd 1490 (London: Her Majesty's Stationery Office, 1961), p. 7. Data on technicians are unavailable on a census basis for the total labor force, but for a sample survey of "engineering and chemical industries". Ministry of

Labor, "Survey of the Employment of Technicians in the Chemical and Engineering Industries", Ministry of Labour Gazette LXVIII (December, 1960), p. 464. No estimate of the total number of engineering technicians is drawn from the ratio of 4.20 technicians to engineers, found in the survey, for the following reason given in this report: "Because the sample of firms was a relatively small one no attempt was made to deduce from the results of the survey the total number of technicians of various kinds employed or required throughout the selected groups of industries." (p. 464)

(c) SOURCE: Max Rutzick and Sol Swerdloff, "The Occupational Structure of U.S. Employment, 1940-60", Monthly Labor Review 85 (November, 1962), p. 1211.

(d) SOURCE: Alexander G. Korol, Soviet Research and Development: Its Organization, Personnel, and Funds, (Cambridge: Massachusetts Institute of Technology, Center for International Studies, Working Draft no. D/60-20, forthcoming study sponsored by the National Science Foundation), Appendix A, Table A-1.

(e) SOURCE: Arnold Kramish, Research and Development in the Common Market vis-à-vis the U.K., U.S. and U.S.S.R., (Santa Monica, California: Rand Corporation, mimeographed, p-2742, 1963), Table 14, p. 48.

Assuming that the ratios shown in Table I are approximately correct, the variation may be accounted for in terms of differences in the educational institutions and value systems of these countries. In Britain and on the Continent, the educational system is elitist in comparison to the egalitarian, mass-educational system of the United States. At approximately 11 years of age, there is a weeding-out process on the basis of scholastic performance with the result that a relatively small proportion of students are eligible for a college education. Thus, for working-class boys in Britain and in some European countries to attend an institute for the training of technicians is evidently regarded as representing substantial upward social mobility. In the Soviet Union, too, we are told that, "To have a son graduate from a technicum ("school of specialized secondary education") is a great achievement for a family of modest background" (Korol, 1957, p. 110). Hence, in these cultural settings engineering technicians are not so inclined to perceive their occupation as involving the same extent of marginality as their counterparts in the United States do. The value placed on achievement and social mobility in the United States appears to be so great that the American working-class boy who cannot afford a four-year college education and who enters a two-year technical institute is apt to feel that he is settling for a "second best" occupation. Some may rationalize their choice by saying--as did one student at Wentworth Institute--that "The difference between us and an engineer is that we cram for two years and they loaf for four years" (Brady et al., 1959, p. 99), thereby asserting, in effect, that they are the equal of college-engineering students. Small wonder that in a country like the United States where everybody is exhorted to accomplish his utmost and where there are provisions for mass education at the college level, it is difficult to induce high school graduates, expecially the majority that do not enter college, to attend a technical

institute. Nor does the widespread "tendency to conceive of the... educational system as a single ladder leading from elementary school through the university" (Smith and Lipsett, 1956, p. 3) mitigate the difficulties of recruiting students to technical institutes. Whereas the United States produces about 35,000 engineers a year, the number of yearly graduates from technical institutes is in the neighborhood of 15,000 (The President's Science Advisory Committee, 1962, p. 23; Metz, 1962, Table 1). Instead of producing a ratio of 2-5 engineering technicians per engineer, which some educators advocate (Beatty, 1958, pp. 24-25), we are producing approximately 0.4 engineering technicians for one engineer. In the Soviet Union there are about 1,200 technical institutes training approximately 225,000 engineering technicians per year (DeWitt, 1961, p. 190; Engineers Joint Council Delegation to the U.S.S.R., 1961, p. 21). In 1960, according to Korol, the Soviet Union trained 111,000 engineers and 255,800 or 2.3 technicians for each engineer (Korol, working draft D60/20, Appendix A: Tables A-14 and A-15). And to insure that the graduates of these "technicums" become engineering technicians and not engineers, only the top 5 per cent of these graduates are permitted to continue their education for an engineering degree. (Korol, 1957, p.113). In a universalistic-achievement society such as the United States (Parsons, 1951, pp. 180-200), it is difficult to motivate people to enter a relatively low-prestige, low-salary occupation such as that of the engineering technician. On the other hand, in a particularistic-achievement society such as the Soviet Union, or in universalistic-ascriptive societies such as Britain and some other European countries, the problems involved in recruiting entrants to the engineering technician occupation are substantially less than they are in the United States.

One direction for coping with the shortage of engineering technicians in the United States is to recruit women into this occupation. The proportion of women in this occupation, though not as miniscule as in the engineering profession, is still very low--on the order of 14 per cent (Brady et al., 1959, p. 52). Since there is already a cultural precedent for employing women as technicians in other fields, notably in medicine and dentistry, the obstacles to extending the practice to this occupation might not be insurmountable. The major source of resistance may be from the engineer himself who, by force of tradition, may prefer to work with male engineering technicians. A corollary problem would be the reluctance of women to enter a predominantly male occupation. Apart from the cultural precedent which would facilitate the recruitment of women into the engineering technician occupation, there is a large supply of women who, because of early marriage and the completion of child-bearing in their thirties, are prepared to re-enter the labor force (Evan, 1957, pp. 387-89). Out of necessity and not only because of their ideology regarding the status of the woman, the Soviet Union has recruited a large number of women into the ranks of engineering technicians--approximately 38 per cent of the members of this occupation (McCrensky, 1958, p. 157).

The recruitment of women might go a long way toward reducing the scope of the problem of marginality of engineering technicians in the United States. Viewed as a pre-marriage or post-child-bearing occupation, the level of occupational aspirations would be radically lower for women than they are for men. Consequently, we would expect their relative status profiles to be more equilibrated than are those of male engineering technicians.

CONCLUSION

A marginal role, whether occupational or otherwise, frequently is a barometer registering storms, so to speak, in the social system. In a rapidly industrializing society problems of manning a perpetually-changing occupational structure are bound to lead to a considerable amount of role strain. The engineering technician's marginality is a reflection of ongoing processes of change in the occupational structure in response to emerging technologies. Just as craftsmen represent older technologies, engineering technicians may be viewed as representing the technologies of an era of growing automation.

As in the case of other occupations, the clamor for professionalization of engineering technicians may increase and take various forms: a) an insistence on a titular revolution--the standard use of such terms as "junior engineer" or "assistant engineer"; b) an insistence on formal education in a technical institute or a junior college, and an Associate degree in engineering as qualifications for the standard professional title; and c) the establishment of an independent association to develop its occupational identity and to protect its economic interest, though not necessarily by means of traditional collective bargaining procedures--in order to avoid the stigma of a manual occupation (Foote, 1953, pp. 371-380; Hughes, 1958, pp. 131-138).

Pressures for professionalizing the engineering technician occupation may result in a reduction of the marginality of this occupation. If these pressures materialize, they may also result in the incorporation of this occupation as a specialty within the engineering profession as a whole. If this were to happen it would be analogous to the ongoing process to bring the X-ray technician occupation within the ambit of the medical profession

(Gross, 1958, p. 223). In general, pressures for the professionalization of the engineering technician occupation in particular, and of white-collar occupations in general, will probably become more insistent in a society in which the proletariat is progressively being replaced by an expanding salariat (Bell, 1956, p. 50).

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