Chapter I

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The professions and the professionals have come to occupy a position of importance and prominence in modern society which is unprecedented in history. The number of professions has multiplied in all advanced societies and has become a part of the production system which is increasingly based on science and science-based technology.

It is a difficult task to offer a comprehensive definition of a profession. Not only has the concept of profession a variety of meanings attached to it but also the group of occupations called profession has been assigned contradictory notions and cultural outlook. Moreover, the historical background of professions differs tremendously. While some professions can be traced to the hoary past, other occupational titles subsumed under profession have appeared only recently. Therefore, one comes across various definitions of profession in the sociological literature. 1

Generally by 'profession' is meant those occupations which are based on practice and ideology of people who call their occupations a profession and claim certain prerogatives, and, in exchange, they offer or claim to offer certain services due to expertise they possess by way of specialized training. This, in
turn, results in creation and control of a protected or institutional market.

Sociologists have categorized the characteristics of a profession in a number of ways (Carr-Saunders and Wilson: 1933; Goode: 1960; Etzioni: 1961; Yossifov: 1979). Some of the major attributes of professions are (i) a body of abstract knowledge, (ii) professional authority, (iii) service orientation, (iv) community sanction, (v) professional-client relationship, (vi) code of ethics, and (vii) a professional culture.

Two major approaches have evolved in the study of professions. These are functionalist and Marxist approaches. The basic assumption of the functionalists are: firstly, the professionals make important contributions to the well-being of the society as a whole, secondly, they serve all the members of society rather than particular groups, thirdly, they are concerned with service to the community rather than with self-interest. But these functionalist assumptions have been questioned in recent times (Mills: 1951; Illich: 1975; Parry and Parry: 1976).

Marxists have taken a different view of a profession. They see professionalism as a self-interested strategy to improve the market situation of an occupational group. A profession obtains a monopoly on a particular service which it jealous guards. In the absence of competition it can obtain a high return for its services. By controlling entry into the profession, it can limit the number of practitioners and maintain
a high demand and therefore a high reward for its services. It creates a demand for these services by fostering the myth that they are valuable to the client. Professional ethics, particularly the emphasis on altruism, care and community-service are simply a smoke-screen which serves to disguise professional self-interest.²

Some of the Marxist thinkers like Baritz (1971) have taken a more radical posture and have dubbed the professionals as "the servants of power". From a Marxian perspective, it involves the proletarianization of the professional which entails the loss of independence by professional groups. Increasingly, professionals are directly employed by the state and private industry. Industry employs lawyers, specializing in business, commercial and cooperation laws and accountants dealing with the growing complexities of company finance. Similarly, scientists, civil, mechanical and electrical engineers are salaried employees rather than independent practitioners charging fees for their services. As such, members of these professions can be seen as the servants of the capitalist class. A similar argument applies to the personal-service profession (e.g. psychiatry, social work, nursing, teaching and medicine) employed mainly in the service of the state; they serve the interests of the ruling class or the ruling elite rather than the community as a whole.
The increasing division of labour and mechanization in modern industrializing societies has given rise to a number of occupations which because of their specialized theoretical knowledge, intellectual training, internal organization and professional ethics and autonomy have achieved the status of a profession. However, not all occupations occupy the same professional status. The degree of professionalization varies in each professional group. There are professions such as medicine, divinity, teaching, etc. which are considered as 'established professions' or 'classical professions'. There are other professions which have attained the status of profession because of the demands of contemporary technological society. The professions of scientists, engineers, natural and social scientists are examples of such 'new professions'. Still there are other professions which may be dubbed as 'semi-professions', 'marginal professions' or 'would-be professions' in which some of the essential attributes of a profession are missing or these attributes are found in a very small measure.

As regards the professional status of science and engineering there exists divergence of opinion among the social scientists. While Morris and Carr-Saunders (1955) have treated these occupations as 'new occupation' yet the exact nature of the professional status of these occupations and the degree of professionalization among them is a matter of dispute. The period preceding immediately
before industrialization have been characterized by lonely enterprises in the sphere of science and technology. The names of the greatest men of science - the Newtons and the Einsteins - evoke images of isolated individuals grappling with momentous, mind-boggling problems. These individuals worked in isolation and created great scientific inventions and discoveries. However, the contemporary situation is entirely different. The scientists and engineers are not working in isolation but are very much a part of the industrial bureaucracy, work organizations, research institutions and government departments.

Science and engineering are the two most vital professions of contemporary society. The edifice of the modern urban-industrial order hinges upon these professions. These professions are indispensable for the creation and sustenance of the industrial society. As regards the process of professionalization both these professions show similar characteristics. Their members possess specialized knowledge and training, work in organizations whose clients are generally big corporations or government. In both the professions, the code of conduct and professional ethics as well as the interest of the members are guarded by the professional associations. However, both the professions lack autonomy and independence, which are considered to be the salient characteristics of an ideal profession, because of the all-powerful influence of the state or big corporations whose instrument these scientists and engineers have to become.
Different degrees of professionalism exist among scientists and engineers. In general, the scientists as a group differ significantly from engineers as a group. Scientists are typified as 'cosmopolitans' and engineers as 'locals'. A scientist is relatively more concerned with meeting professionally-defined standards, with contributing to knowledge and publishing, with gaining recognition from professional peers, with engaging in basic and applied research, etc. The engineer is relatively more concerned with contributing to the goals of the work institution, with gaining recognition from hierarchical superiors, with bureaucratically conforming conduct in order to gain personal regards of status, salary, etc. The engineer's self-image is that of one trained in the special expertise necessary to transfer technical and scientific knowledge into goods and services to meet social needs.

However, engineers represent a class of professionals who are rarely self-employed and are engaged as salaried employees in government and private work-organizations. Therefore, some of the ideal-typical characteristics of a profession are found missing in the engineering profession. These professionals find it difficult to act autonomously or independently. On the one hand, they have to act within the bureaucratic limitations of their work organizations and, on the other, their role is circumscribed by the broader politico-economic forces of a society as also by the level of its technological development.
Science and engineering have traditionally been seen as the enterprise of men. Throughout its long history, science has been populated almost exclusively by men. As regards women in engineering, historically, this phenomenon has been almost nonexistent. Both these professions are considered as male-dominated professions. Women's entry in these professions is considered as an attempt to cross the sex barrier. In the West, more particularly in the U.S.A. where massive development in science and technology has taken place and where the number of persons employed in these professions is large, the participation of women is unequal to that of men (Edgerton: 1962; Rossi: 1965a, 1965b; Epstein: 1970; Rossi and Calderwood: 1973; Zuckerman and Cole: 1975).

In India, the growth of science and engineering professions as compared to the Western countries is still in a nascent stage and the participation of women in these professions has been very nominal. A coherent and comprehensive picture of women's unequal participation in science and engineering is just not available. Neither are there aggregate data, comprehensive surveys and governmental reports which could present the status of women in science and engineering professions in India in its proper historical and socio-economic perspective. Nor are there adequate number of micro and atomistic empirical studies available which could unravel the nature and extent of women's unequal
participation in these professions. Therefore, to arrive at a proper understanding of women's position in these professions we would have to juxtapose the materials which are scattered in in some reports and articles.

Unfortunately in India, the split-data on employment situation of scientists and engineers either organization-wise or specialization-wise are not available. Sex-wise data are either not available at all or if available allow little comparability.

Though the CSIR in collaboration with the Census of India gathers data on the "Degree Holders and Technical Personnel" along with its decennial census enumeration, yet not all information is available in the form of published reports. Relevant information available on the employment situation of scientists and engineers of India is contained in "Educational-Occupational Pattern in India" published by the Ministry of Labour, Government of India (1980). According to this report, in the year 1978 in public sector the total number of persons employed in "science and related occupations" was 58,171, of which only 1,611 (2.77 per cent) were women. Subject-wise there were only 5 women (0.59 per cent) physicists, 273 (4.32 per cent) chemists, 14 (0.55 per cent) geologists and geophysicists, 53 (4.71 per cent) meteorologist, 103 (3.28 per cent) biologists, zoologists, and botanists, etc., 135 (10.70 per cent) sylviculturists, 397 (1.18 per cent) agro-
nomists and agricultural scientists, 126 (4.43 per cent)
bacteriologists, pharmacologists and related subjects, 3
(18.75 per cent) mathematicians, 93 (4.04 per cent) statisticians,
13 (13.98 per cent) geographers, and 396 (9.33 per cent)
"scientists not elsewhere classified". Thus, in all subject-
fields of science, the participation of women vis-a-vis men is
unequal and of very limited nature (see Appendix II).

The women's employment in private sector (India: 1979)
unfolds the same pattern. In the year 1979 there were 17,994
persons engaged in "science and related occupations". There
were 1,026 women (5.70 per cent) in science-based occupations.
Of these 324 were in chemistry constituting only 2.63 per cent
of the total. In other subject-fields their representation
was as follows: 37 (9.04 per cent) physicists, 86 (15.95 per
cent) biologists, zoologists, botanists, etc., 353 (44.34 per
cent) sylviculturists, 54 (2.88 per cent) agronomists and
agricultural scientists, 105 (15.78 per cent) bacteriologists,
pharmacologists, etc., 6 (0.74 per cent) statisticians, and 61
(15.44 per cent) "scientists not elsewhere classified". It
seems that women scientists are not getting enough employment
opportunities in private sector, too (see Appendix II).

Thus, the position of women in science both in public
and private sectors cannot be construed as very satisfactory.
The position becomes more gloomy when we look into the data
concerning women's participation in engineering and related
occupations. In the year 1978, in public sector the total number of "engineers" was 1,39,944 of which only 1,639 were women which constituted only 1.17 per cent of the total.

Subject-wise distribution was as follows: 109 (4.65 per cent) women were architects and town-planners, 299 (0.60 per cent) were civil engineers, 482 (1.42 per cent) were electrical and electronic engineers, 83 (0.38 per cent) were mechanical engineers, 30 (1.00 per cent) were chemical engineers, 8 (0.70 per cent) were metallurgists, 4 (0.11 per cent) were mining engineers, 25 (0.66 per cent) were industrial engineers, 22 (0.47 per cent) were surveyors, 3 (0.45 per cent) were aircraft pilots, 24 (2.55 per cent) were ship and deck officers and pilots, and 550 (4.09 per cent) engineers were "not elsewhere classified". There were no women found as flight-engineers, flight-navigators, or ship engineers. Thus, it is clear that only architecture and town-planning is the branch in which the male-female ratio is higher as compared to other engineering fields. Though, in electrical and electronic engineering the number of employed women is higher than in the other occupational groups, the male-female ratio is lower than in architecture and town-planning.

In the private sector, there were 57,501 persons who were engaged as "engineers", of which 512 were women which constituted only 0.89 per cent of the total. The subject-wise break-up was as follows: There were 10 (5.05 per cent) women as architects
and town planners, 12 (0.43 per cent) as civil engineers, 161 (1.91 per cent) as electrical and electronic engineers, 68 (0.27 per cent) as mechanical engineers, 18 (0.51 per cent) as chemical engineers, 3 (0.27 per cent) as metallurgists, 2 (0.67 per cent) as mining engineers, 5 (5.05 per cent) as aircraft pilots, 8 (23.52 per cent) as flight engineers, and 222 (1.68 per cent) as "engineers and technologists not elsewhere classified". There was only one woman each found in private sector as a surveyor, and a ship-deck officer, there was no woman as ship engineer or flight navigator. Thus, in private sector too, the proportion of women as compared to men in all occupational fields of engineering is very low.

The Council of Scientific and Industrial Research (CSIR) is one of the major employers of scientific personnel in India. In July 1980, the number of women scientists in CSIR was 162 (4.24 per cent) in the total of 3822. Of these 29 per cent were at the level of scientists 'A', 40 per cent at the level of scientist 'B', and 20 per cent at the level of scientist 'C'. It is interesting to see that while only about half of the total scientists in the CSIR belong to levels of 'A' and 'B', 70 per cent of the women scientists belong to these levels. At the senior levels of 'E-1' or above the total number of scientists was 543. They constituted 1/7th of the total number of scientists in the CSIR but included only 6 women scientists. In all, women scientists holding senior posts constituted only 4 per cent of
the total strength of women scientists compared to about 14 per cent among all the scientists in the CSIR (see Appendix III).

The employment situation of women in science and technology in India can further be understood through the Research and Development (R & D) Statistics published by the Department of Science and Technology, Government of India. According to the survey of this department conducted in 1980-81, out of 1.84 lakhs personnel employed in R & D organizations only 6 per cent were known to be women, half of which were employed in administrative jobs and only one-fourth engaged in actual R & D activities. Out of 2,985 women science and technology personnel engaged in R & D the educational qualifications of 2,896 personnel were known and are given in Appendix IV.

It may be seen that more than half of the women engaged in R & D were having post-graduate or higher qualifications. Looking at it from another angle it is found that more than half of them were from the area of natural sciences. Only 19 per cent of the total women who were engaged in R & D activities were engineers. Most of them possessed graduate degrees or diplomas in engineering (see Appendix IV).

According to a survey of the Department of Science & Technology, as on April 1978, there were 920 (6.56 per cent) women in R & D wings of the major scientific agencies, of which 96 (7.41 per cent) were in the Department of Atomic Energy,
290 (5.42 per cent) in C.S.I.R., 291 (5.44 per cent) in I.C.A.R.,
96 (26.02 per cent) in I.C.M.R., 147 (14.23 per cent) in D.S.T.
and none in the Department of Electronics. In all these major
scientific agencies/organizations the number of women was 2,168
which constituted only 5.35 per cent of the total work force.
In R & D the women constituted 6.56 per cent, in auxiliary 3.51
per cent and in administrative and non-technical jobs only 5.75
per cent.

In Central Ministries/Departments the number of women
employed in R & D organizations was 754 which constituted only
3.34 per cent of the total. In R & D there were 272 (2.91 per
cent) women, in auxiliary 242 (3.12 per cent), and in adminis-
trative and non-technical jobs there were 242 (4.41 per cent)
women. Thus, the proportion of women was higher in non-technical
and administrative jobs. Within R & D, the relative proportion
of women was found higher in energy-coal (64.28 per cent) followed
by Health and Family Welfare (24.19 per cent).

In different states of India, the number of women employed
in science and engineering was 827 which constituted only 3.92
per cent of the total. In R & D the number of women was 287 (2.98
per cent), in auxiliary 212 (5.58 per cent), and in administration
and non-technical jobs, their number was 330 (4.30 per cent).

In the private sector, the total number of women employed
in R & D organizations was 553 which constituted only 2.71 per
cent of the total. In this sector in R & D, the number of women was 316 (3.29 per cent), in auxiliary the number was 86 (1.99 per cent), and in administration and non-technical jobs the number was 151 (2.33 per cent).

Thus, the statistics provided by the Department of Science and Technology again confirm the lower representation of women in Research and Development organizations of the Central and State Governments, as well as in private sector. Another noticeable point is that within R & D organizations of the major scientific agencies, Central and State Governments, the highest proportion of women was employed in the administrative and non-technical jobs, which are non-scientific in nature and carry less prestige and monetary rewards. In Central and State Governments' R & D organizations, the proportion of such women as were engaged in actual R & D activities was lower in comparison to that in other activities (see Appendix V).

Bhabha Atomic Research Centre (BARC) is one of the major scientific establishments in India. According to a survey conducted by Bhatt and Iyengar (1986), out of 13,535 employees in BARC, the strength of women was only 1,409 (10 per cent). They were employed mostly in administrative (46 per cent) or auxiliary works (10 per cent). In scientific and technical categories the proportion of women was only 9 per cent and 5 per cent of the
total, respectively (see Table 1, Appendix VI). It may further be seen from the table 2 of the Appendix VI that in the professional scientists' category, at the highest levels of scientist 'G' and 'H', there were no women. On the other hand, at the lower levels of scientist 'B', 'C' and 'D', the proportion of women was 6 per cent, 9 per cent and 8 per cent, respectively. Similarly, in the technical category, the highest proportion of women was found in 'A' and 'C' categories (18 per cent and 17 per cent of the total, respectively). On the other hand, in the higher categories of 'E', 'F' and 'G', women formed only 6 per cent, 3 per cent and 1 per cent of the total, respectively.

Similarly, Indian Institute of Sciences (IISc), Bangalore had only 4 per cent women in its faculty (Abbas: 1980). Again, five Indian Institutes of Technology employed 1,766 persons in their faculties, of which only 58 (3.28 per cent) were women. In Indian Space Research Organization (ISRO), in 1980, the total staff strength was 3,279 persons, of which only 146 (4.5 per cent) were women (India: 1981).

Another important point to be noted about the lack of visibility of women in science and engineering professions is that no separate data on women are maintained by the voluntary organizations and by most of the governmental agencies probably because of women's very poor representation in these fields.

Some idea about the professional recognition of women
scientists may be had through their position in Indian National Science Academy (INSA), which at the time of its inception in 1935 was known as the National Institute of Sciences of India (NISI). It is recognized as the premier society representing all branches of science in the country. From the year 1935-36 to 1963-64 there were 25 Presidents of INSA, out of which none was a woman. Out of 28 members and office bearers in the council of INSA for the year 1984-85, only one was a woman. Out of the 18 local chapters affiliated to INSA, only one local convenor is a woman. Recently, the Golden Jubilees Celebrations of INSA was held. For this purpose a steering committee was formed consisting of 20 'eminent' scientists of the country. Out of these only one was a woman. A National Commission has been set-up by the Academy in consultation with the Ministry of Education to supervise the compilation and publication of the History of Sciences in India. Out of 21 persons who were members of this committee only one was a woman.

A committee comprising all chairpersons of all Indian National Committees for various International Unions and Commissions (for the period 1981-85) has been formed consisting of 32 members and office bearers. Of these, none is a woman. The low representation of woman is further highlighted by the fact that out of 227 members and office bearers who were in different national committees of International Council of Scientific Unions (ICSU) for the period 1981-85, only 6 were women.
INSAS has instituted as many as 17 medals in different scientific disciplines which are awarded to the scientists of outstanding achievement and excellence in the field of research, and for the spread and growth of scientific knowledge. Till 1980, 80 outstanding scientists have been awarded these medals, out of which none is a woman (INSAS: 1980). The list of scientists selected for the award of Science Academy Medals for young scientists from the year 1974 to 1984 reveals that out of 161 awardees only 14 were women. The enquiry further reveals that out of 117 delegates who attended 18th General Assembly (1982-83) meetings/symposia/conferences, etc., abroad and were financially supported by INSA, only one was a woman. Out of 113 scientists to whom financial assistance was sanctioned for the participation in non-ICSU conferences, etc., during 1982-83 only 4 were women. Out of 28 INSA-funded travel-fellowships to young scientists during the same period only 2 were women. Similarly, the list of projects sanctioned to different scientists during the same year reveals that out of 85 projects sanctioned only 7 were given to women (INSAS: 1980). There were 44 laboratories and research institutes attached to the CSIR and spread all over the country; none of these laboratories or institutes was headed by a woman.

In 1981, the Ministry of Social Welfare had set-up a working group to review the extent of participation of women in scientific establishments at different levels. The working group analysed the employment situation of women in science and technology and noted that there is lack of complete data on the participation of women in scientific and technical positions. The
data that could be available for individual establishments show women's insignificant number and also their representation at comparatively junior levels with very few women at higher policy levels. There is, moreover, a definite preference for some subjects like biology and chemistry with very few of them taking up careers in engineering, earth sciences, etc. (India: 1981).

Another dimension of the status of women in science and engineering professions in India is related to the education and training of the women in professional subject fields in the higher educational institutions. It is a well-known fact that there has been considerable increase in the enrolment of women in higher education since independence, yet the growth is mainly confined to the fields of humanities and social sciences rather than to science and technical subjects (Jaiswal: 1979; Krishnaraj: 1985; Ahmad: 1986). In 1950-51, the total number of women enrolled in higher education was 40 thousand. This constituted 14 per hundred men. This figure grew over the years and in 1982-83, the enrolment of women in higher education reached 880 thousand which constituted 39 women per hundred men (see Table 1, Appendix VII). This is a substantial increase keeping in view the structural constraints which are there in India inhibiting the women's entrance into higher education and also in the context of stringent economic status of the families who send their women for higher education (Phadke:...
Decennial growth in the enrolment of women in science reveals that in 1950-51, only 7.1 per cent women were enrolled in science which grew to 10.5 per cent in 1960-61, 17.8 per cent in 1970-71, 28.7 per cent in 1980-81, and 29.4 per cent in 1982-83. The gross enrolment of women in science was 9,046 in 1950-51 which grew up to 1,82,009 in 1982-83 (see Table 2, Appendix VII).

Whereas science did attract a significant portion of women students in higher education and their enrolment is increasing over the years, their proportion in the total enrolment is far from satisfactory in the field of engineering. In 1950-51, only 19 women students were enrolled in engineering/technology which constituted 0.2 per cent of the total. In 1960-61 this figure grew up to 403 which constituted 0.9 per cent, in 1970-71 this further grew up to 901 women students which constituted 1.0 per cent of the total. Only in the seventies a spurt in the enrolment of women in engineering becomes visible. In 1980-81, there were 4,949 women students which constituted 3.8 per cent of the total. In 1982-83 the total enrolment of women in engineering/technology reached 5,990 which constituted 4.2 per cent of the total. Thus, slight progress has been registered in women's education in engineering in the seventies and in the early eighties, yet the enrolment is not as large as it is found in science faculty during the
corresponding decades (see Table 2, Appendix VII).

For a closer understanding of the women's enrolment in science and engineering, subject-wise data for the year 1982-83 may be analysed in greater detail (see Table 3, Appendix VII). It may be seen that in 1982-83 the total number of men and women enrolled in higher education was 31,33,093. Among these 8,80,156 were women, which constituted 28.1 per cent of the total. The major concentration of these women was in education (47.0 per cent) followed by arts which constituted 38.7 per cent of the total. Science constituted the third largest faculty in which 28.8 per cent of the total enrolment was that of women. In medicine 27.8 per cent of the total students were women. In other faculties their proportion to the total enrolment in that faculty was as follows: commerce 17.4 per cent, law 7.4 per cent, engineering/technology 5.1 per cent, agriculture 4.0 per cent, veterinary science 4.8 per cent. Thus, the trend of enrolment even in 1982-83 is heavily tilted towards the traditional subject fields like arts, humanities, social sciences and education, the subjects which are considered rather soft and do not require heavy investment. This tilt has got serious implications for women's entry into the job market. As these faculties mainly provide recruitment to general administration and teaching jobs, the competition between men and women is quite tough. Women are likely to find lesser employment opportunities and to opt for lowly paid jobs. This may result
in unsatisfactory and disadvantageous placement of women within the work organization. It may also result in considerably higher level of unemployment among the women holding degrees and diplomas in humanities and social sciences.

As against the heavy concentration of women in humanities and social sciences, the proportion of women in professional subjects barring the exception of education and medical sciences has not been found very significant. Thus, women have yet to achieve parity with men in professional subject fields.

We can now direct our attention to the fellowships/scholarships awarded by the Council of Scientific and Industrial Research which can further exemplify the unequal participation and unsatisfactory growth rate of women in specialized scientific and technical subjects. In the year 1981, the CSIR had awarded 4,308 fellowships. Of these 1,356 fellowships were awarded to women which constituted only 31.47 per cent of the total. The split figure for women is 512 senior research fellowships (26.14 per cent), 844 junior research fellowships (35.91 per cent). Subject-wise distribution of the fellowships awarded to women was as follows: 22.62 per cent in physics, 27.69 per cent in maths, 33.90 per cent in chemistry, 38.62 per cent in bio-chemistry, 29.60 per cent in medicine, 38.19 per cent in biology, 5.84 per cent in earth sciences and 11.86 per cent in engineering (see Appendix VIII). This distribution further exemplifies that women
even in science and engineering are opting for those subjects which could provide them only teaching or research assignments. Such science and technology based professions as are physically more demanding and are therefore the preserve of men, are attracting comparatively lesser involvement of women.

A look at the participation of women may be further had through the award of Research Associateship. In 1981, out of 86 Research Associates in various disciplines, there were only 30 women (34.88 per cent). The largest number (60 per cent) of women Research Associates have been found in biology which indicates the preferential subject choice of women who are rather represented less in other subject-fields. Only one woman was awarded Associateship in engineering and three in earth sciences (see Appendix IX).

The available figures about the education and employment of women in science and engineering in India indicate that there is unequal participation of women in these areas. The women's entrance into these men-dominated fields is not only a recent phenomenon but also a restricted one. Therefore, there is need to know the nature and extent of this unequal participation of women through more accurate and exhaustive information.

REVIEW OF STUDIES

To understand the unequal participation of women we can now proceed to review the micro-level studies having been con-
ducted in India and foreign countries. At the outset, it may be stated that there is a paucity of literature on women's status in science and engineering professions in India. Therefore, in order to understand the substantive issues relating to women's participation in science and engineering professions, one has to look towards foreign studies.

In the United States, one of the earliest attempts to understand the position of women in science has been made by Rossi (1965a). Utilizing 1960 U.S. census data she has shown that women accounted for 65 per cent of the increase in the labour force between 1950 and 1960. A few occupations have actually changed from predominantly masculine fields to feminine fields such as bank-tellers, school teachers, typists, etc. But there has been no such dramatic change among the professional and technical occupations during the decade under study. Women have registered a growth of 26 per cent only. In many occupations the number of women has risen strikingly over the decade but the increase of men has been so much greater that the proportion of women in the total has actually declined. The field of mathematics is a good illustration of this: there has been a 210 per cent increase in the number of women, but the number of men in mathematics increased by 428 per cent, with the result that the proportion of mathematicians who are women actually declined from 38 per cent in 1950 to 26 per cent in 1960. The pattern noted for mathematicians holds true to some degree in most of
the other fields. Physicists, chemists, geologists and geophysicists, and biological scientists among the women have increased in absolute numbers during the decade - but their proportion becomes less when we take into account the number of men in these professions (Rossi: 1965a).

Rossi (1965a) has also made a comparative study of 1950 and 1960 U.S. census data on the position of women in engineering. In 1950, the total population of the engineers was 5,26,179 which rose to 8,60,949 in 1960. Women constituted less than one per cent of the total number of engineers in 1960. The main specialisation in which the women were concentrated were Industrial (2.1 per cent) followed by aeronautical engineering in which they constituted 1.6 per cent of the total. In other fields their population was: 0.9 per cent in chemical, 0.6 per cent in civil, 0.8 per cent in electrical, 0.3 per cent in mechanical, 0.9 per cent in metallurgical, 0.3 per cent in mining, and 0.3 per cent in sales (see Appendix X).

To explore the phenomena of unequal participation of women in the science profession in the U.S. several empirical studies have also been conducted. One of the earliest attempts in this direction has been made by Cole and Cole (1973). In their work on 'Social Stratification in Science', they have collected data from several sources on a sample of 499 men and women scientists in the fields of chemistry, biology and
psychology. They have found that men and women scientists tended to wind up in academic departments of equal prestige. In chemistry and psychology, however, women are somewhat less likely than men to be found in top departments. In biology, where there is a great number of women in academic positions than in the other two fields, women do slightly better than men.

They have also shown that some differential treatment of women does occur in the social system of science, but not as much as many critics of the scientific reward system would like to project. Women scientists are every bit as natively able as male peers who receive their training at equivalent departments. Yet women scientists, regardless of their marital status or the size of their families, simply produce fewer scientific papers, papers of less impact than men in comparable positions. When quality and quantity of papers are taken into account, sex status has only a minor effect on the prestige of the scientists' academic affiliation. Sex status does have a significant independent effect on the overall academic rank of scientists. Women are not as frequently promoted to senior positions, especially at the better universities, as are the men who come from the same doctoral departments. As regards discrimination they conclude that the amount of discrimination against women scientists is small.

Cole's 'Fair Science: Women in the Scientific Community' (1979) is another comprehensive documentation of women's status
in science in the U.S. He has studied more than 2,000 men and women scientists, matched initially in terms of the university from which they receive their degrees, the year they receive the degree, the initial field of activity, and the speciality in which they did doctoral work. He has traced the careers of the scientists for twelve to twenty years collecting data as well on aspects of their social backgrounds including their I.Q.s, and marital and family statuses, on their career histories such as job changes, dates of promotions, prestige of their affiliations, etc. He has also collected data on the 'reputational standings' among a group of peers for a sample of roughly 600 men and women scientists.

The results of this investigation show evidence from the Ph.D. onward of significant gender-based discrimination in the promotion of women scientists to tenure and high academic rank. Even after taking into account many other factors, such as career interruptions and the quantity and assessed quality of research performance of men and women, Cole has found that women are still less likely than men to be promoted to higher academic rank.

The findings of Cole's study have been supported by several authors such as Darland et al. (1971), Astin and Bayer (1973), Loeb and Ferber (1973), Gordon et al. (1974). Their studies in the early seventees showed that highly educated women are rewarded less than men with equal qualifications. New studies appearing recently such as that of Centra (1974), Bayer and Astin
(1975), Appleton et al. (1976) document the fact that women are faring somewhat better but still earn less and are promoted more slowly than equally qualified men. Other recent studies such as those of Feldman (1973), Johnson and Stafford (1974), Lester (1974) argue, however, that the low representation and the low rank of women on college campuses in general and in more prestigious institutions in particular is caused not primarily by discrimination but by women's choice to invest in human capital. Women are more seriously concerned with family obligations and would not prefer any interference in it because of occupational roles.

If the participation of women in science has been characterized by inequality and low status, it is lower and more unequal when we review the situation of women's participation in engineering. In the United States, where considerable development in technology and industry has taken place, the case of women engineers can be illustrated fully well. In 1960, in the United States 7 per cent of employed physicians and surgeons were women, 9 per cent of the natural scientists, 2 per cent of the earth scientists, 4 per cent of the physicists, 26 per cent of the mathematicians, 27 per cent of the biological scientists and less than 1 per cent of the engineers were women (Torpy: 1964; Rossi: 1965a). Exploring the reasons of women's insignificant participation in engineering, most of the socio-psychological studies in the U.S. have laid emphasis on the

The sociological and psychological researches concerning engineers indicate that they are narrow of interest, stolid, relatively uninterested in 'cultural' things and not inclined to general pursuits (Harrison et al.: 1955; Davis: 1961; Robin: 1962; Wilensky: 1964). These characteristics are considered rather masculine and therefore, not suited to women's personality structure. Most of the personality traits which are considered essential for an engineer are fundamentally incompatible with the interests, aspirations and personal characteristics of women who would otherwise select the field for an occupational career (Robin: 1962, 1969; Cobb: 1979).

Many women do not select engineering as an occupation because their socialization has produced "traditional" or "domestic" women for whom an occupational career is not a viable alternative. Others decline engineering because the traditional image of the profession as a masculine pursuit is strong. Still others fear discrimination in this profession. Some women find themselves prevented by social circumstances such as marriage, children, and other traditional obligations. Finally, even emancipated women are also subject to ambivalence through socialization in a society where a rapidly changing normative
system fails to provide clear sanctions for whole-hearted participation in fields like engineering (Seward: 1945; Rose: 1951; Rossi: 1965b).

In recent times, considerable amount of work has been done to empirically verify the reasons for unequal participation of women in science and engineering professions. Some of these researches have led to the exploration of subject choice at school age. Girls apparently have as much opportunity as boys to pursue science subjects but a wide range of influences are at work to persuade the girls that science is not for them (Kalia: 1982). Kelly (1982) has suggested four important reasons for the lack of girls' interest in science. Firstly, there are some biological differences between the sexes which predispose boys to opt for science subjects and girls to opt for arts. Secondly, lack of self-confidence and the fear that science is too difficult for the girls. Thirdly, there is the masculine image of physical sciences. And fourthly, the apparent remoteness of science from girls' every day concern.

As regards the biological differences between the sexes which are supposed to predispose boys to opt for science subjects and the girls to opt for arts, a difference in spatial ability is supposed to be behind this. Scientists generally score higher than non-scientists on tests of spatial ability, and there is a well established sex difference on these tests with boys scoring higher than girls. During the 1970s it was
widely held that spatial ability was partially inherited via an X-linked recessive gene and was therefore manifest more often in the males than in the females. More recent data has cast doubt on this hypothesis, although that does not disprove all biological explanations (Kelly: 1982).

However, biological factors cannot be the complete answer. In many countries, particularly in Eastern Europe, a large number of women study science successfully without any biological handicap. Nor are biological predispositions necessarily relevant when formulating educational policy. Girls usually score better than boys on verbal tests, and boys have more difficulty than girls in learning to read.

Whether its origin is biological or social it cannot be stated with certainty that sex-differences in spatial ability lie at the root of the problem. They are just as likely to be a symptom. Children who play with construction toys and handle tools probably develop both their spatial ability and their scientific aptitude in the process. And child-rearing practices ensure that such toys and tools are much more frequently made available to boys than to girls.

The way children are reared is important in developing children's self-image. In most of the societies masculinity is associated with independence, self-reliance, strength and leadership. Femininity is associated with conformity, passivity,
nurturance and concern for people. Child-rearing practices which diminish girls' self-confidence may be particularly detrimental to their science education. Ormerod (1982) has found that both girls and boys tend to prefer and choose the subjects they think are easier. Even girls who achieve good results in physical sciences seem to lack the self-confidence to choose these difficult subjects. Moreover, Harding (1982) has shown that girls do worse on multiple choice tests - which again require self-confidence to pick one correct answer - than on structured or essay type tests, which allow more room for qualifications and hesitation.

Boys may be more willing than girls to continue science even though they find it difficult because they see it as relevant to their careers. Both girls and boys take interest in the subject and relevance to a career is the principal reason for choosing science! Whereas boys tend to overemphasize the importance of science for careers, girls tend to underemphasize it. Girls may also be discouraged from studying physical sciences by its masculine image. A glance at science text-books shows numerous examples concerned with guns, cars, football and machinery - all topics which interest boys more than girls. The vast majority of illustrations in the text-books show men or boys. The Men of Science series posters prominently displayed in many school laboratories contain only one woman - Marie Curie. Also, unlike the men, she is shown surrounded by her family.
Physical sciences not only have a masculine image but also project an impersonal image. School children think that science deals with things, rather than with people. Much of what they learn in science is abstract and theoretical with little connection with their daily lives in the present or the future. Caring for people, both, physically and emotionally, is an important part of the female-role, and a subject which apparently ignores people may seem irrelevant to girls' concerns.

In Britain, much work has been done to find out sex-differentials in science and engineering. The first conference in Britain on sex differentiation in schooling was held in Cambridge in the early eighties. In this conference some of the eminent British and American researchers and educationists discussed the origin of educational inequality between boys and girls and its possible cure (Blackstone and Weineich-Haste; 1980). In this conference Kelly showed through an international study that boys consistently did better than girls in a standard science test in all the industrial societies studied (though girls in some countries, notably in Japan and Hungary, did better than boys in others, notably in Italy and Belgium). In Britain, at least, unequal opportunities for training, especially apprenticeship, increase the skill-gap further. This is particularly true for science and technology.

Sex-differences in cognitive abilities have no biological or physiological base. By the age of eleven and sometimes
earlier, boys and girls show different levels of language and skills and spatial reasoning but it is becoming clear that this is susceptible to training. Practice helps, and so does play. It was reported at the Cambridge Conference that "feminine" and "masculine" interests expressed through the toys they play with and irrespective of the actual sex of the child were important variables in verbal and spatial skills. Fairweather (1976) has reviewed a large number of studies and noted that sex differences in cognition have been overstated and have no physiological basis. Differences within each sex are greater than between the sexes. Spatial reasoning seems to correlate with scientific ability and interest. The differences in the capacities of teenaged boys and girls to study science should be traced to environment and motivation rather than to biology of the sexes (Blackstone and Weineich-Haste; 1980).

REVIEW OF STUDIES IN INDIA

The study of science and engineering professions in India, somehow, has not yet captured the attention of social scientists in a significant way. Moreover, the available studies deal with the professions and the incumbents in a general way. Barring one or two exceptions there has been no attempt to study the women in these professions. To understand the situation in these professions, we can now make an attempt to review some of these studies.
Barely half a dozen studies have been conducted on the science profession in India. These studies deal with two major areas i.e. scientists as professionals, and organizational dimensions of the scientific profession. Profiles of scientists, their role perception and professional activities, their problems and frustrations are some of the identifiable themes in the study of scientists. On the other hand, the study of organizational aspects of the scientific profession has concentrated on the institutionalization of Western science in India, and organizational variations in the work-environment and their bearing on the professional satisfaction or dissatisfaction of the scientists.

The study of socio-economic characteristics of scientists does not present a consistent profile. Ahmad and Gupta (1967) have found that majority of the scientists are drawn from low income families having a non-scientific occupational background. On the contrary, Aurora (n.d.) reports evidence of an overwhelming majority of the "urban middle class castes" with some from families with a professional background.

Dey (1969) has analysed the 1961 census data on inter-state migration of scientists. He has pointed out that some states are net exporters and others are net importers. The major exporting states are Kerala, Mysore and Punjab in that order, while the major importing states are Delhi, Bihar,
Maharashtra, Madhya Pradesh, Gujarat, Orissa, Assam and Rajasthan.

As for role-perceptions, a large majority of scientists entertains an active researcher self-image, while only a minority harbours a routine worker self-image (Ahmad and Gupta: 1969). With regard to professional activities, it is noted that most of the scientists are academically well-equipped and trained (Chandra: 1970) and they publish their research largely in Indian journals and acquire membership of professional societies in India (Ahmad and Gupta: 1967). The average number of publications and of membership in scientific or professional societies is directly related to age and experience, although low salaried and junior scientists spend more time on research than the high salaried and senior scientists, much of whose time is consumed by administrative obligations (Ahmad and Gupta: 1967; Chandra: 1970).

The scientists have little communication outside their organizations (Ahmad and Gupta: 1967; Pruthi and Nagpaul: 1978). Scientists in private or industrial research establishments tend to communicate internally more than those in other sectors, and the high salaried scientists communicate more - both internally and externally - than the low salaried (Ahmad and Gupta: 1967). In a study of the pattern and role of communication in Research and Development (R & D), Pruthi and Nagpaul (1978)
found that much of the communication within the project team was "irregular" and most of it was directed either upward or downward with very little lateral communication.

Chandra (1970) has done work on the problems and frustration of scientists. While a majority of the scientists are satisfied with recognition of authorship in publication, a significant minority is not. The partiality shown by the superiors is a major cause of grievance among the scientists.

The organizational aspect of scientific profession has been studied by Aurora and Rao (1977). They have tried to explain the growth of the Western scientific tradition in India. On the basis of historical facts they argue that in the first phase itself a section of the indigenous intellectuals quickly grasped the idea of power embedded in Western scientific education. In the second phase, namely, that of colonial science, there was a halting development of scientific institution building in most sectors particularly in the area of industrial research and the applied sciences. With the emergence of professional organizations such as the Indian Science Congress, the urbanization of the scientific community made considerable progress. The third phase, according to the authors, developed in correspondence with the growth of indigenous industrial capitalism and the maturity of the Indian intelligentsia.
Concentrating on scientists in four major sectors, namely, industrial, agricultural, medical and university, Aurora (n.d.) has probed into the linkage between the organizational and decision-making structure of each sector and the scientists' satisfaction or dissatisfaction with the infrastructural facilities for research and with the promotional opportunities and recognition for work done. His findings reveal that the scientists in the private laboratories are more satisfied with the promotion and recognition aspects than those in CSIR (Government) laboratories. He finds considerable evidence of dissatisfaction among the scientists in the government laboratories - more in the state government run laboratories than in the Central Government sponsored institutions - which he attributes to a degree of mistrust between the administrative staff and the working scientists. Similarly, he presents evidence of high dissatisfaction among the scientists in the agricultural research system and explains it in terms of a high degree of concentration of power in the hands of the divisional heads and directors of institutions. In organizational respects, he finds that the situation of medical scientists is considerably different in professional terms, as compared to those in the industrial and agricultural sectors. The medical scientists have been found to enjoy greater professional autonomy than the other scientists. Finally, the scientists in the
university sector are highly satisfied with the academic freedom but greatly dissatisfied with the various physical facilities and career-development opportunities.

Coming over to the profile of women in the science profession we find that not a single comprehensive study has been done so far. Only one small-scale survey could be found in this connection. Desai (1978) reports a study conducted by the research unit of the SNDT Women's University on a sample of 400 working women in science establishments (12 Teaching, 7 Research, 12 Hospitals and Government Departments, 12 Industrial Units). This survey revealed that - (i) two-thirds of women scientists covered were married. Among the married two-thirds had children, (ii) the majority of the women began their careers before marriage and continued, (iii) in terms of salary, position and managerial power they were at middle level, (iv) the women reported a supportive family situation (both children and adult), (v) 82 per cent claimed satisfaction with their careers and perceived no obstacle of any kind, (vi) a lower need was felt for professional competence and advancement.

Krishnaraj (1980) has observed that the majority of men and women are excluded from the benefits of scientific knowledge, as science is an elitist activity. Women are excluded to a greater extent as the literacy rate for women is very low.
Within the elitist establishment, women as a class hold a secondary position, in terms of number, diversification, posts held, salary drawn, and all such criteria. They have not by and large earned positions of power and prestige in the high status scientific profession. She observes "women of a certain class have benefitted from science education, though this benefit is unlikely to filter down to the rest of the women, or only to a limited extent even to their own homes, but even this class of women benefit less than men, because they are women .... Neither in their domestic role nor in their occupational role have women been able to optimise the benefits of science."

Gurnani and Sheth (1984) have reviewed the position and role of women scientists in India through available statistics. They observed that because of certain historical and cultural factors, Indian women are late starters in scientific professions. Being late entrants, the proportion of women in science is relatively small. The majority of them are employed at lower levels. Not many women are found at policy making levels. They have also observed that although Indian women scientists do not face any apparent discrimination in education and employment, they quite strongly feel that their male colleagues and superiors do not accept them professionally. Indian women scientists are passing through a transitional period. Their choice of science as profession is yet restricted to its use-
value as an instrument for making a living more convenient. Few women consider science-careers in order to express their personhood or to achieve attitudinal changes in outlook. As professional persons, Indian women scientists do not live in isolation from their culture. They continue to consider their family roles more important than their professional roles.

As regards engineering there is not a single full-length study of the engineering profession in India. About half a dozen research papers in journals are all that the literature on engineering profession comprises. Part of the existing literature is preoccupied with student engineers and part of it with practicing engineers. The organizational framework of the engineering profession has remained, by and large, unstudied except for some observations on engineering education.

The studies of student engineers have focussed on two points, namely, (i) their socio-economic antecedents and, (ii) the career aspirations, job preferences and commitment to engineering. The studies of the first category can be further sub-divided into two: those concerned with issues of equal opportunity and social mobility (India: 1966; Rajgopalan and Singh: 1968) and those addressed to the issues of industrial policy and man-power planning with particular reference to problems of brain drain and regional disparities (King: 1970a, 1970b).
Attempting a discipline-wise break-up of engineering students in India by their socio-economic background, King (1970a, 1970b) presents further evidence suggestive of the role of engineering in reinforcing the existing class structure. His data indicate that students in most preferred disciplines, such as electrical and mechanical engineering, in which employment prospects are better, came from more privileged backgrounds, while students in the least preferred disciplines, such as civil and textile engineering in which employment prospects are dim, came from relatively less privileged backgrounds.

Examining the career aspirations and job preferences of engineering students, King (1970a, 1970b) draws attention to the "fortuitous ways" in which careers are chosen and the "fragile loyalty" to an engineering career. While over one-half of the students reported their intention to take up engineering as their profession, about one-third were willing to take up what they perceived as non-engineering jobs. Further, out of the several career alternatives such as design, construction, production, etc. career in management and administration was the craze with the majority of the respondents.

The studies of practising engineers have focussed on their changing status and role, their job involvement and its factors, and the problem of perennial conflict between elite professionals and administrators. Commenting on the status
and role of engineers, Dutta (1970) reports some decline in the status of the engineers in India and attributes it to their over-supply and unemployment. Nevertheless, the author maintains that on the whole the engineer's status is still very high and his industrial role is still very significant. Drawing a profile of employed engineers in government service, Sharma and Sharma (1978) suggest that they occupy a higher job position, are older, have put in more years in service and perhaps have a higher technical education. In a study of elite engineers in the irrigation branch and of the concerned administrators Singh (1975) found ample evidence of a crystallized awareness of mutual conflict on the part of both engineers and administrators. The engineers viewed administrators as outsiders.

Coming to the organizational context, only engineering education has received some attention. In a critical piece on engineering education, Devon (1971) observed that "current policy on technical education in India as in the West, is dominated by the "manpower model". This, according to him, leaves something to be desired particularly because it lacks a concern for the humanistic and ethical dimension which is a vital ingredient of professionalism.

About women in engineering no detailed empirical investigation has been conducted in India so far. In a study reported as early as 1968, Khubchandani on the basis of a survey conducted
by post found that most of the women engineers covered in the survey were employed in design and development, teaching and research. The study reported that most of the women got permission from their parents to take up engineering course without hesitation. The majority of women engineers reported that their profession interferes with their household responsibilities.

In 1981, the Ministry of Social Welfare set-up a working group to formulate personnel policies for bringing greater involvement of women in science and technology. This group after having reviewed the extent of participation of women at different levels had also considered the factors that contributed to the low participation of women in careers in science and technology. The group felt that the low participation is the result of various social and cultural attitudes and the lack of requisite educational and other facilities to enable them to opt for education in these fields. The working group observed "Social attitudes about girls' education are also responsible for this situation. Many parents place a higher value on the education of their sons than that of their daughters. While the boys are expected to look after their parents in their old age, and their education, especially professional education, is seen as increasing their ability to earn better, this is not seen as important for girls and their joining scientific and professional
education is not given serious consideration... It has also been noted that whereas the parents would be willing to send boys to outside places for studying science and technology, they do not consider the education of girls equally essential and desirable. They are also reluctant to send girls to educational institutions away from home in absence of hostels."

The foregoing review of the literature on the status of scientists and engineers leads to the following conclusions:

(1) That the science and engineering professions in India are the least explored areas of study.

(2) That the participation of women in these professions is nominal, yet it is a gradually developing phenomenon. Moreover, it is characterized by women's participation in certain preferred areas within these occupational fields and is further disproportionate to the number of men in these professions.

(3) The studies also refer to the discriminatory practices against women which are rooted both in the institutional/organizational context as well as in the general socio-cultural milieu.

(4) The review has also indicated that the sex-role, socialization, sex-typed images of occupations, sex-based prejudices and stereotypes do play important role in the recruitment of women to the jobs as well as the treatment meted out to them on the job.
Therefore, there is a need for in-depth sociological enquiry into the professional status of women in science and engineering professions in India. This will throw light not only on the unequal participation of women in these professions but also provide insight into the basic issues and problems attached to the emergence of women's rightful position in the contemporary Indian occupational structure. Such an exploration would also provide an understanding of the nature and characteristic of the ongoing changes in the status of women in Indian society.
Notes

1. Some of the important definitions of professions are as follows:

(a) According to Carr-Saunders and Wilson (1933) "...a profession emerges when a number of persons are found to be practicing a definite technique founded upon a specialized training. A profession may perhaps be defined as an occupation based upon specialized intellectual study and training, the purpose of which is to supply skilled service or advise to others for a definite fee or salary."

(b) According to Parsons (1939) "I conceive a profession to be a category of occupational role which is organised about the mastery of and fiduciary responsibility for any important segment of a society's cultural traditions including responsibility, for its perpetuation and for its future development. In addition a profession may have responsibility for the application of its knowledge in practical situations."

(g) According to Cogan (1953) "A profession is a vocation whose practice is founded upon an understanding of the theoretical structure of some department of learning or
science and upon the abilities accompanying such understanding. This understanding and these abilities are applied to the vital practical affairs of man.

... the profession, serving the vital needs of man, considers its first imperative to be altruistic service to the client."

(d) According to Greenwood (1962) "... professionalism is one that views a profession as an organized group which is constantly interacting with society that forms its matrix, which perform its social functions through a network of formal and informal relationship and which creates its own sub-culture requiring adjustment to it as a pre-requisite for career success."

(e) According to Cheek (1967) "Professions are those occupations which involve the use of knowledge and techniques by a practitioner directly upon, or in behalf of, a client in order to maintain, or induce in, the client a culturally determined and socially approved state of well-being."

(f) According to Parry and Parry (1976) "... a strategy for controlling an occupation in which colleagues set-up a system of self-government."
According to Oxford English Dictionary (1970) "... a profession is a vocation in which professed knowledge of some department of learning or science is used in its application to affairs of others or in the practice of art founded in it."

2. From Marxist point of view, Oppenheimer and his associates (1977) have defined profession in the following manner:

"Until recently, 'profession' meant work involving discretion and judgement so that it is difficult or impossible to standardize or mechanize work in which the worker produces entire product, be it a printing, a surgical operation, a book, a bridge, or an idea; where worker's pace, work place conditions, product, its use (even to a degree its price) are largely determined by the workers, where ideally the source of income is an individually regulated sale or product or service under fairly loose market conditions established by face-to-face bargaining rather than sale of labour time in advance of the creation of anything, and where the bulk of the income goes to the worker without any bureaucratic intermediary except perhaps an agent (as in the case of an artist). Finally, by implication, professional activity is work involving high levels of training, apprenticeship, or other forms of formal education. Professionalization is a process by which persons in an occupational category struggle to gain the advantages of being professional."