

## FEMALE STUDENTS IN ENGINEERING Geology, Mining, and Petroleum Engineering Comparison\*

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Engineering professions generally went last decades through process of feminization, but not equally. The article is focused on one of the most male dominant profession – mining, geology and petroleum engineering (MGPE). This study will examine the percentage of female students and graduates from mining college and their achievement on undergraduate level in eleven years period. Data show a significant differences in female students enrolment among geology (35% women) and mining and petroleum engineering (14% women). The theoretical background in explanation why women are marginal group in MPE is based on two different approaches: technological determinism and social shaping of technology. The role of technology in altering of women position in society is significant. The social construction of technology thesis stresses social factors and interests of main actors which in this case include the reproduction of traditional value system and occupational segregation.

**Ključne riječi:** žene, rudarstvo, geologija, naftno rudarstvo, feminizacija profesija, tehnološki determinizam, socijalni konstruktivizam

Inženjerske profesije prolaze posljednjih desetljeća kroz proces feminizacije ali ne u jednakoj mjeri. Članak se bavi profesijama u kojima su muškarci dominantni: rudarstvu, naftnom rudarstvu i geologiji. Analiza ispituje broj upisanih i diplomiranih studentica i njihov uspjeh na R-G-N fakultetu u razdoblju od jedanaest godina. Podaci pokazuju razlike u prosječnom broju upisanih studentica geologije (35%) te rudarstva i naftnog rudarstva (14%). Teorijsko objašnjenje zašto su žene marginalna skupina na R-G-N-u zasniva se na dva pristupa: tehnološkom determinizmu i socijalnom konstruktivizmu. Uloga tehnologije u promjeni položaja žene u društvu je značajna. Socijalno konstruktivistička teza naglašava društvene čimbenike i interese glavnih aktera, što u ovom slučaju znači reprodukciju tradicionalnih vrijednosnih sustava i segregaciju zanimanja.

### Introduction

Participation of women in dominantly male professions is subject to change over time due to legally equal access to high education and professional type of career. Process of feminization of some professions has been subject of sociological analysis like education, medical, veterinarian profession (Šporer, Tadić, 1987, Cerjan-Leticica, 1987). Engineering is still predominantly male profession despite all social, normative, democratic and technological (microelectronics) changes in contemporary society. (National Science Foundation, 1984, Evetts, 1996).

How can be explained that women are so poorly represented in engineering, which are social or technological barriers for them and how to increase their participation in these professions? Obviously, legally equal access to high-school and university education does not necessarily mean that this will actually happen in all professions. This article is focused on social cultural factors influencing gender structure of engineering career analyzing female enrolling in mining, geology and petroleum engineering (MGPE) and possible differences between these three groups.

### Women in mining, geology and petroleum engineering. State of the art

Today in the most modern countries women and men are equally represented in college education but more important are differences in types of education. Very early in the school boys express more interests in science and maths, and girls excel in verbal skills, which resulted in over representation of men in fields of hard sciences and engineering and women in education and humanities. Engineering professions generally went last decades

through process of feminization but not equally. In 1981 in US 10.3% of bachelor's degree in engineering were awarded by women, while according to U. S. Department of Labour in 1985 7% of engineers were women. (Brinkerhoff and White, 1988, Farley, 1990). In year 1987/88 there were 12% of women in science and engineering course in UK (Evetts, 1996). Massive influx of women into science and engineering of professions is a recent phenomena in US. Almost 60% of women reported fewer than 10 years of professional work experience 1986 (NSF, 1992). Bureau of Labor Statistics figures indicate that women are underrepresented among those employed as engineers (8% women), and among certain categories of natural sciences, for instance geologists and geodesists (14% women). Data for mining and petroleum engineers show in 1988 4% of women among mining engineers, and 6% among petroleum engineers. Women scientists and engineers are more likely than their male colleagues to be unemployed and underemployed. The unemployment rate for women in science and engineering in 1986 was 2.7%, and 1.3% for men (NSF, 1992). This difference between education and actual occupational status is itself a good example of occupational segregation.

In Croatia we can expect a little bit different situation concerning the proportion of women in professional education and paid jobs. As an ex-socialist country it has the heritage of ideology of egalitarianism which was extended to the professions. In former Yugoslavia (Croatia was part of it) in seventies 14.6% engineers, 39.5% veterinarians and 46% physicians were women. (Sklevicky, 1987).

Mining and petroleum engineering are both typically male dominated professions with comparatively smaller rate of women than geology and other engineering professions. At the Faculty of mining, geology and petro-

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leum engineering at University of Zagreb in last eleven years (1986–97) average proportion of female students were 21%, and average percentage of graduates was 26%. Comparing three departments (geology, mining, and petroleum engineering) there can be noticed a significant difference between geology and other two groups (Tables 1, 2, 3). While geology is closer to common pattern of women in university education, mining and petroleum engineering keeps the number of female students rather constantly low (Figures 1, 2, 3).

The difference in share of women between mining and petroleum engineers are not significant except a recent trend of little stronger feminization can be noticed.

Nevertheless, low rate of women persisted in engineering and the question to be answered is why.

There are two kinds of social factors which influence the process of feminization of professions with the opposite effects:

1. First, concerning the type of social system and its dominant ideology. There are differences in political and economical emancipation processes of women in western societies and former socialist countries. Unlike western type of emancipation, which was a result of conscious movements and different groups pressures, the former socialist countries characterized emancipation from the top through normative and legal system (Šporer, 1990). Ideological basis of former socialist countries due to rule of egalitarian values, enable women to enter the professions but this same egalitarianism brought processes of glorification of physical work («were are all workers») and anti-professionalism which lowered the status of professions generally in the society.

Although women are significant population in some professions that is not the case in mining and petroleum engineering.

2. Second social factor is common to western and ex-communist countries, it is called occupational segregation. Occupational segregation refers to concentration of men and women into different occupations caused by sex-role socialization and modelling. Repeated and selective exposure to particular behaviour pattern results in modelling of that pattern and good example of that are different occupational aspirations of boys and girls. Despite some significant changes in modern society in gender roles most boys and girls plan job that traditionally belongs to his/her own gender. In the case of engineering, educational influences on career choice are good results in maths and sciences, mentors, and career advice (Evetts, 1996). On the high school level achievement in these subjects is equal, or girls are even better, but later they don't pursue professional career which requires good training in science. Why girls give up? It seems that occupational segregation is most present in fields where attitudes about gender roles are most traditional (Abrahamson and Sigelman, 1987). The tradition of mining as male profession can explain while at the same time in the same faculty there is constantly very low rate of female students of mining and petroleum engineering, and constantly higher in geology.

Is tradition only responsible for it? Keeping high score of professional prestige is the interest of every member of certain profession. Professions with high status keep it high by few mechanisms: protection of professional monopoly by legislation, and controlling the enter into profession. Comparative studies proved that massive entering of women in certain profession (teaching) means lowering its prestige, regardless of political sys-

tem (Tavris and Offir, 1977, Šporer, 1990, Jacobs and Steinberg, 1990).

#### *Who is better student?*

If occupational aspirations by sex and different success in maths and hard sciences can be seen very early as a result of modelling traditional behaviour pattern, it can be expected that women in engineering are not as good students as their male colleagues having lower grades and longer period of studying.

As Table 4 shows female students are better in both dimensions, they have higher grades and shorter period of studying. The explanation of such data could be given in sense that women who want to make career in engineering have to be much better than men and are much higher motivated.

Comparison of the average number of enrolled and graduated students in all three departments show that percentage of female graduates exceed the percentage of enrolled women in all three departments. (Table 5)

#### **A sociological explanation of sex differences in engineering**

Limited to the aspect of representing women and their professional success on university education as indicators of status in male dominated field, this analysis is attempt to find plausible interpretation of the state of the art. The theoretical background of analysis why women are marginal group in MPE is based on two different general theoretical approaches: technological determinism and the social shaping of technology. In authors opinion both approaches can bring some plausible explanations of the phenomena.

#### *Is technology women liberator?*

The main proposition of technological determinism is that technology has the character of independent and autonomous agent of social change (Smith and Marx, 1994, Westrum, 1990). All interpretations stress importance of technology for social change, but how and why is technology so influential show different approaches. According to technological determinism once certain technology is started, it requires certain organizations and political resources. The role of technology in altering the women's position in society would be significant. Modernization with political and economical emancipation opened the possibility of formal education and paid employment. Beside that machine based production and today computer technology rendered male-female strength difference increasingly irrelevant (McGinn, 1991). At the same time technology is by some feminist and non feminist authors responsible for imposing dominant male perspective on human experience (Williams, 1994), reproducing certain model of sex roles, position of power in working sphere, trying to sustain gender statuses from earlier epochs. «...continuing attempts by men to exclude women from traditionally 'male occupations' even when technologies were introduced that rendered differences in physical strength irrelevant» (Drygulsky Wright, 1987).

Social constructivism of technology puts the accent on the key role of relevant actors, groups and individuals in a process of shaping technological systems which then shape institutions, organizations, power structures. Technologies are defined as heterogeneous and contingent (Bijker and Law, 1989). Heterogeneity means that different factors such as theories, politics, social factors are included in process of technological change. Contingency is basic feature of technologies for they don't

Table 1. Percentage of enrolled and graduate mining students

Year	M <sub>enr</sub>	F <sub>enr</sub>	M <sub>grad</sub>	F <sub>grad</sub>
1986	88.00	24.00	82.14	17.86
1987	81.56	18.44	92.00	8.00
1988	88.19	11.81	91.30	8.70
1989	86.01	14.69	83.87	16.13
1990	94.73	5.27	92.86	7.14
1991	92.43	7.57	75.00	25.00
1992	86.53	13.47	83.33	16.67
1993	93.18	6.82	73.91	26.09
1994	81.82	18.18	81.82	18.18
1995	84.33	15.67	75.00	25.00
1996	80.61	19.39	87.10	12.90

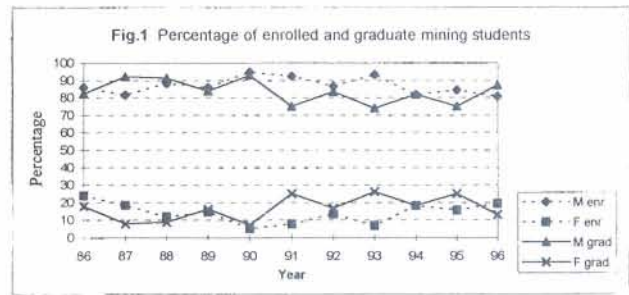


Table 2. Percentage of enrolled and graduate geology students

Year	M <sub>enr</sub>	F <sub>enr</sub>	M <sub>grad</sub>	F <sub>grad</sub>
1986	54.76	45.24	28.57	71.43
1987	55.55	44.45	50.50	50.00
1988	64.79	35.21	60.00	40.00
1989	72.63	27.37	55.17	44.83
1990	73.46	25.64	51.72	48.28
1991	82.35	17.65	50.50	50.00
1992	69.23	30.77	54.17	45.83
1993	57.33	42.67	44.44	55.56
1994	69.56	30.44	70.27	29.73
1995	43.47	56.53	61.29	38.71
1996	62.50	37.50	61.29	38.71

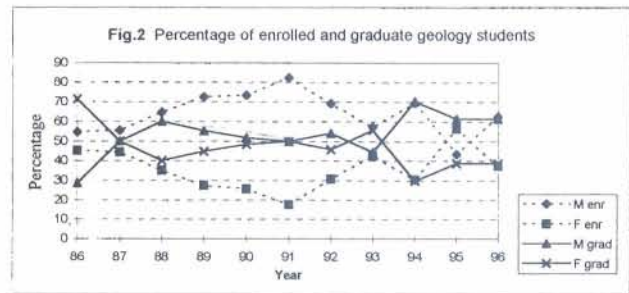


Table 3. Percentage of enrolled and graduate petroleum engineering students

Year	M <sub>enr</sub>	F <sub>enr</sub>	M <sub>grad</sub>	F <sub>grad</sub>
1986	92.15	7.85	95.23	4.77
1987	88.23	11.77	68.42	31.58
1988	88.23	11.37	72.00	28.00
1989	93.54	6.46	75.00	25.00
1990	84.00	16.00	81.08	18.92
1991	95.00	5.00	81.25	18.75
1992	83.33	16.67	86.11	13.89
1993	87.50	12.50	95.45	4.55
1994	78.26	21.74	84.61	15.39
1995	75.00	25.00	94.44	5.56
1996	83.33	16.67	92.86	7.14

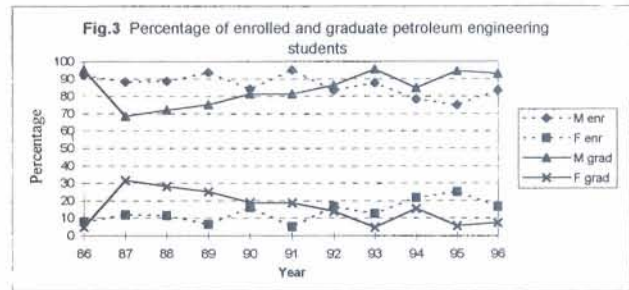


Table 4. Average grade and years of study by sex in MGPE in period 1986-97

Department	Sex	Average mark	Average years of study
Mining	Female	3.39	8.18
	Male	3.31	8.08
Geology	Female	3.86	7.49
	Male	3.98	8.30
Petroleum	Female	4.05	6.14
	Male	4.04	7.47
Total	Female	3.76	7.27
	Male	3.77	7.95

Table 5. Average percentage of enrolled and graduate female students in MGPE in period 1986-97

Department	Enroled (%)	Graduated (%)
Mining	14.12	16.51
Geology	35.85	46.64
Petroleum	13.73	15.79
Total	21.23	26.30

emerge from inner independent technical logic, i. e. they might have been different. This approach put the main accent on social, economical and other nontechnical factors which in case of this analysis would include the reproduction of traditional value systems, where there is

clear distinction between male and female jobs, modeling, occupational segregation. Engineering is also profession with high prestige score and maybe keeping low entering of women is mechanism of keeping that the high prestige?

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