

## Women into Engineering

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*ABSTRACT: Nowadays, because of the women rights to seek equal opportunities in the workplace, more and more young female population in the age range to study in the higher education apply for the professional courses that a few decades ago was for male population such as in civil engineering courses. This paper intends to present the strategic plan being carried out in an Academic Institution that offers the Production Engineering Course with effort in Civil Engineering. The survey carried out among over 300 associates showed the needs to improve the acceptance of female engineers in the civil engineering, whereby the preference for male engineers is around 8 out of 10. The number of female students in the engineering has experienced an increase in last decade reaching the ratio nearly one to one. Thus, in the near future, the female graduates in engineering will face difficulties for the job placement. The proactive action should be devised by the academic institutions and the associations concerned to work towards an adequate information strategy to explain about the achievement of skill sets by female engineers to perform professional tasks properly, as much as a male engineers. To reinforce the studies towards this issue, the results of survey was compared to those obtained by similar institution in Germany. Distinct methodology was used, but as the survey was for the same purpose, results can be compared and discussed for further consideration to devise the policy towards the issue of women into engineering.*

### 1 INTRODUCTION

The gender relation in general and the division of labor among women and men are in the stake in several countries and also in several sectors of the life. Different influences had unleashed this evolution, embracing since the discussion on human rights to the availability of human resources, which women represent the half.

The statistics of the United Nations on Gender Empowerment Measures indicates that governments react in the distinct manner, reaching the broad measures as the concept of Gender Mainstreaming in the European Union over a simple political rhetoric without any action until to forget the issue. Observing only the Gender Empowerment Measures, also the selection of the jobs for women and the rate of women in several academic disciplines, interesting developments can be seen in different countries in the world.

In some countries it can be noticed the quick change that is balancing the distribution of study areas by sex. By the frustration of whom is in tune with quotas or settling policy will not be able to prove a direct relation among the Gender Empowerment Measures, the government and the dynamism of distribution the areas of studies by sex.

In Germany and Norway only can be noticed the minimum change in the rate of sex despite intense effort of the governments. Finally, it can talk in the case of Brazil, the political measures and the process release the male and female enrolment in the technology studies that develops in the same direction.

Evidently the route followed by the countries will not depend only on the industrial development stage or the modernization, also in the culture in the broad sense. This approach will be based preponderance in surveys of long range to relate gender with technology studies. These will indicate and will perform independently two higher education institutions, both with technology orientation:

Fachhochschule Furtwangen in Germany (FHF) and the Federal Center for Technology Education of Paraná (CEFET) in Brazil. From the comparison of results of surveys, the influence of different cultures in the selection of the fields of studies by sex will be determined.

Apart from the influence on culture it worth question whether the actual ratio of sexes in specialties in the universities is in consensus with the idea of the democracy of gender, more real: if the class contents, the methodology and the faculty environment foment adequately all to develop their individual personality and uniqueness.

## 2 OVERVIEW ON GENDER, SCIENCE AND TECHNOLOGY

A glimpse of general idea about the situation towards women into technology of both countries, Germany and Brazil, in national scale will be reported. They form a landmark to illustrate the situation of higher education in technology that will be described in details in the following paragraphs. In both countries the election of the field of study takes specific aspects by sex, women prefer other specialties than those of men. This attitude worth to mention, if different specialties will not drive to serve the job opportunities, that reinforce the inequality gender-specialty as the difference in entrance, status, political participation among men and women and infringe with them against the principle of gender mainstreaming. Germany, the country with lowest birth rate in the world, started to alert organizations such as Association of German Engineers (VDI) or the Association of the German Industries (BDI) about the scarcity of the new generation of engineers. These associations are demanding actions to attract women for technical professions aiming to alleviate the scarcity of engineers. The industries in Brazil, one country with the majority of population younger than German, doesn't have an intrinsic interest by women to go engineering yet.

### 2.1 THE NATIONAL VIEW OF BRAZIL

Regarding to the field of knowledge there are a great difference between women and men in the science and technology. In Table 1 it can be noticed that the number of women is great in the field of humanities, followed by the fields of biology, health, linguistics, and arts. Another hand, in the field as in physics science, engineering and computer science, the number of men is greater, only one quarter of researchers are women.

In the same table the number of researchers by graduation, gender and the field of specialty is displayed. The figures reveal important facts: the difference between the participation of women and men in the field whereby women is the majority, as an example, in the humanities and health sciences, the difference is progressively lesser as the graduation rank is higher. Thus, considering the academic graduation rank, women are in the minority among doctorate degree holders. The difference between women and men is lesser in the fields of "feminine" in the doctorate level, although in the fields of basic science, engineering and computer science, that means, the fields of "masculine", this difference is noticeably greater.

Table 1. Number of researchers by sexes and the knowledge

Field of knowledge	Total	Number of men	Number of women	Percentage of women
Language, Literature, Arts	2874	912	1962	68,3%
Humanities	10811	4301	6506	60,2%
Applied Social Sciences	5843	3075	2766	47,3%
Exact Sciences	7936	5493	2441	30,8%
Biological Sciences	8191	3894	4296	52,5%
Health Sciences	10408	4355	6051	58,1%
Agrarian Sciences	7611	5139	2472	32,5%
Engineering and Computer Sciences	9668	7300	2368	24,5%
Total	63342	34469	28862	45,6%

This data allows to confirm that several women start the professional career as researchers in science and technology, but go until certain period their life, afterwards due to family burden or by not standing the pressure of competition (both motive are related to their gender position) and stop.

## 2.2 SPECIAL VIEW OF CEFET/PR

The Federal Center for Technological Education of Paraná - CEFET/PR is a school of higher education founded in 1909. Has started as a school of arts and crafts for children of poor families, aiming to train them to become workers to fulfill the demand of job places. Today, it has transformed into the Center of higher education, although still keeping a portion of secondary level technician training courses along with courses for undergraduate (associate and bachelor), graduate (master and doctorate) degrees. The Center is located in Curitiba, the capital city of the state of Paraná, in the Southern region of Brazil, with 5 campi strategically spread in the countryside of the state.

Recently, the Center has started the studies on the participation of women and men in the science and technology. As one those oldest school of technical education in the country, still it presents as a strong male dominated environment, although can notice the tendency of rise in the participation of women as students and academic staff.

In total, neither the rate of women nor its distribution over the specialties has changed in the span of time, although the sign of variation over some specialties are noticeable.

## 2.3 SPECIAL VIEW OF FHF

Furtwangen is a small city in the Southwestern of Germany, in the hills of Black Forest. The Fachhochschule Furtwangen with the acronym (FHF), was founded in 1852 is one those smallest and oldest higher technical school in the country. The faculty of informatics is ranked in fifth place among universities in Germany

In the beginning of the year 2002 the TanGenS – Technology and Gender in Applied Sciences – was founded in FHF. In this Center should concentrate and institutionalize the activities on gender of the university. In the winter semester of 2002/3 the Center performed a comprehensive survey with female and male students over the attitude with respect to the technology, studies, career and their life plan. Detailed results were published as work information 1 and 2 of TanGenS that can be downloaded from the homepage of TanGenS in the internet.

## 2.4 THE PROPORTION OF SEXES BY FACULTY AND SPECIALTIES IN FHF

As in all German technical universities the majority of constituent are male dominated. But in comparison with other German technical universities the proportion of female students are considerable. This rise reached up to 25,6% by the students and up to 7,5% by the academic staff. As in the case of CEFET/PR women and men distributed very heterogeneously over disciplines and specialties. In economics, the women prevails clearly lower, in engineering the proportion of women, which forms almost one third of students, is unusual high in terms of German standard, although in informatics women is a minority with only 14,8% of the total, as can be seen in the Table 2.

Table 2. Panoramic view of the proportion of women and men by discipline in 2002

Discipline	Number of women	Number of men	Percentage of women	Percentage of men
Informatics	248	1422	14,8%	85,2%
Engineering	292	703	29,3%	71,7%
Economy	289	150	65,8%	34,2%
Total	829	2415	25,6%	74,4%

Source: Rectorate of the Fachhochschule of Furtwangen (FHF), 2003

### 3 WHY STUDY ENGINEERING OR COMPUTER SCIENCE?

The question that affects the policy, the economics and the universities tells deeply, why women don't study engineering or computer science? Why the proportion of women is too small in the heart of technology? As it is impossible to query the great number of women, it was decided to survey over female students enrolled at CEFET and at FHF. The survey was carried out independently in both institutions of higher education, thus the comparison can not be limited only to the figures, but also the through the common sense.

#### 3.1 THE CASE OF CEFET

The Civil Production Engineering Course of CEFET/PR presents, year by year an increasing number of women. What has noticed that, quite often, that the female students have better academic performance than male colleagues, as an example, in assiduity, results of evaluations, and participation in the class activities. But some of them are not well adapted to the profession, nor can find the job in the market, whereby the preference is for male professionals. Another hand, despite the knowledge and skills attained, not always the female engineers can find the job in their field of specialization.

This reality called for the following question: what the reasons that these younger female persons had elected Civil Production Engineering, one course that they have to work with 'rude workers', a group of men acknowledged as a hostile to have the female participation in their work? What argument justifies the election? What incentives had received to take Engineering Course?

To answer these questions, survey was carried out during the years 2002/2003 among 74 students of Civil Production Engineering Course of CEFET/PR. Approximate age of students were in the range of 19 to 24 years old, and are enrolled between 4<sup>o</sup> to 10<sup>o</sup> semester level, being the majority in the evening classes. Some has been graduated from the course on Building Technical School, and already working in this sector.

Figure 1 presents the answers regarding to the motivation of female students to elect their specialty. First items refer to an intrinsic motivation over the election of the specialty. The majority (65,8%) of women feel the vocation to the technical profession, only 10,8% of women had decided for a technical profession due to the lack of alternatives. Half of them (50,0%) the perspective to get the university degree were important for the election of the specialty. Among external motives, it can be pointed out the influence of friends (90,5%) and limited importance due to family (18,9%), as well as the teachers over the election of the specialty. Almost half of the female students (48,7%) had decided due to expectancy for a good job in the market with the degree, and only 37% were due to expectancy of good wage. Furthermore, 73% of the female students were due to the tuition free courses offered by CEFET/PR.

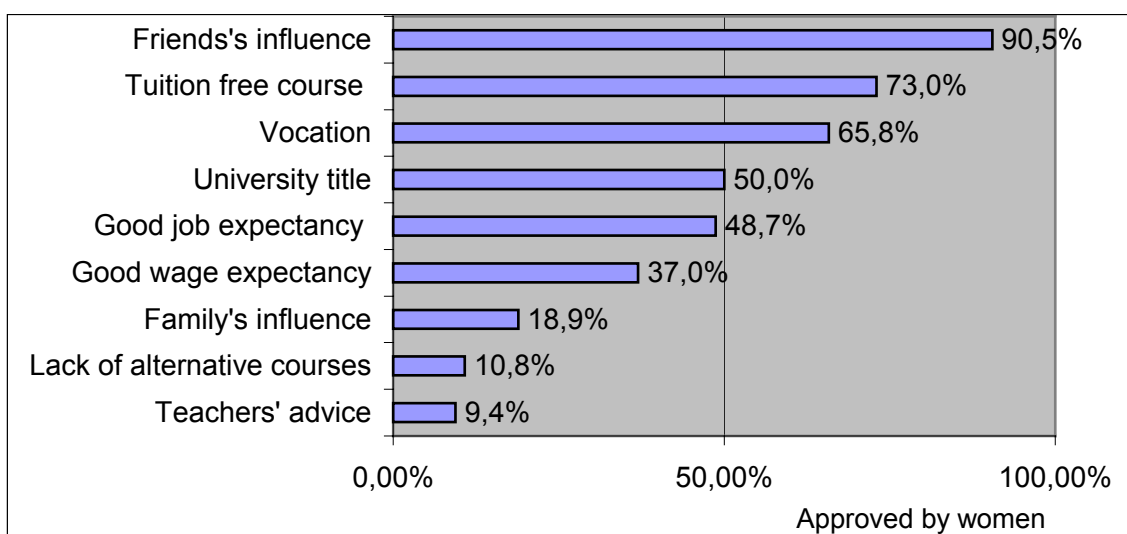


Figure 1- Reason to elect the technical course

#### 3.2 THE CASE OF FHF

One program of the Center the TanGenS, founded in 2002, is dedicated to develop, to implement and evaluate academic modules to sensitize to gender in the selected specialties.

The objective of the measures is to become more attractive and adjusted the studies of the FHF, in the first place for women, but also for men. To prove the effects of the measure to sensitize to gender, students of both gender were queried over their attitudes towards technology, their self images regarding to technology, their expectation for the job and future life, thus the possibility to enhance the education of the FHF. Large questionnaire and interview were performed. In the first bloc of the survey, with the support of questionnaire, 315 students in their first academic year were involved, 94 women and 221 men, with response of 88%. Supplementary survey, with 16 interviews, 9 women and 7 men, was also carried out. Among 68 sets of queries of the questionnaire there were selected those more approximated to the questionnaire applied to the Brazilian students.

### 3.3 THE INTRINSIC MOTIVES

Young German women decided for the technical career with the expectation of job and interest in the field, as shown in the Figure 2. About 86,8% of women the opportunity and the protection of the job place is the strong argument in the favor of the technical profession. Special interests (78,3%), affections and talents (65,5 %), the opportunity of one career (62,7%) as well as the opportunity to develop by the profession (59,0%) are arguments proximately important for women. In the majority of answers, women and men were similar, although men expressed more interest and enthusiasm for technology and informatics. Only the queries, regarding to acquire defective gadgets or knowledge in computers, women and men showed difference in answers: 55,5% of men indicated, that the happiness to acquire defective gadgets is the important motive for the election of the specialty, but only 27,7% of women stated the same; by 49,5% of men on knowledge in computers were the important motive, but only 22,9% of women. Other reasons such as the reputation of the profession in the society or in the family cycles were almost unimportant.

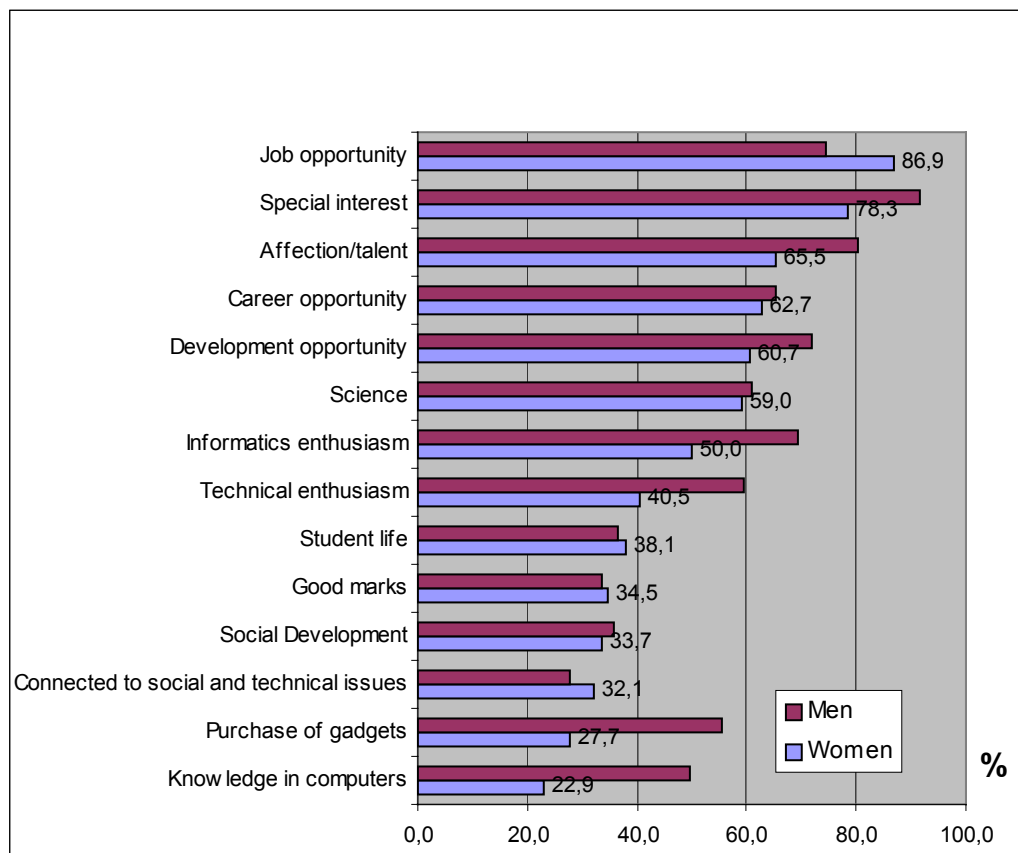


Figure 2 - Reasons to elect technical specialty

### 3.3 EXTRINSIC INFLUENCES

Persons who possibly advised the decision of studies are presented in Figure 3. However, parents exerts a great influence over the election of the specialty of their children, more for daughter than for son. 72% of women indicated, that the mother advised the technical study for her. In second place the advise of female friends are (68,4%) and male friends are (60,8%). Brothers and sisters, relatives, and teachers have a side role in the decision over the election of the technical specialty.

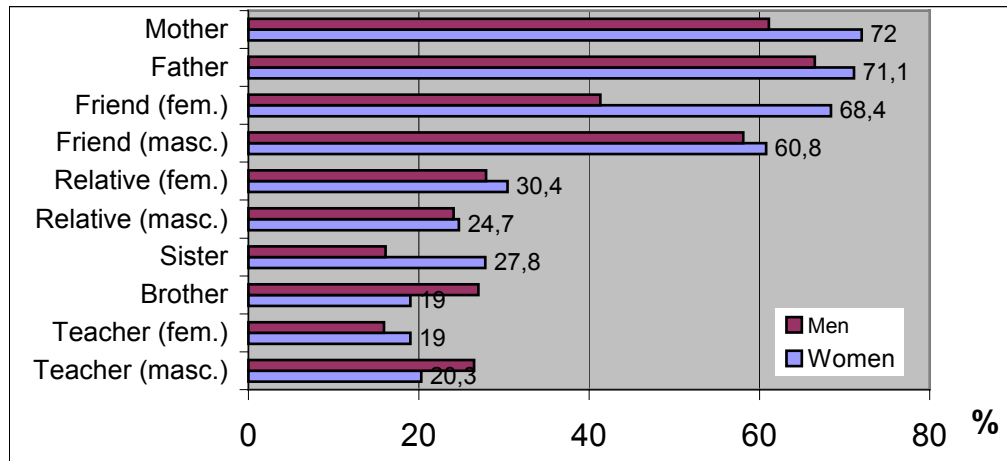


Figure 3 - Persons who advised to elect technical subjects

It is marginal the existence of mature persons to unadvise the youngsters to take the decision for technical profession. With the exception of the female friend, the answers of women and men had not too much difference. 68,4% of female friends advise other friend, 22% don't advise nor disadvise, although only 41,3% of female friends advise the male friend, meanwhile 51,5% didn't pronounce. Women think more frequently over abandon the studies and tends to estimate the success of their studies less optimistic, possibly more realistic, than male counterparts. The students at FHF have broad support in the social environment, if decide for a technical study. Thus, it is difficult to understand why women don't decide in much great number for technical studies and why those who decided are too skeptical regarding to the their efficiency and professional career. Obviously, the reasons for such attitude in their previous life is ought to be serched.

Thus, the question is to know who fomented the interest in technical studies. The possible answer is illustrated in the Figure 4. The most important person acting as the advisor, far from others, for both sexes is the father, followed by male friends and male teachers. The mother doesn't give so much importance regarding to the interest in technical studies. Here, for better understanding, in the context of German culture, technical activities have the masculine connotation, and also more important, because the concepts of social roles. The role of the women and the role of technical profession are not easily compatible. In the present situation, marked by the harsh competition of the job market, the will for the professional recognition prevails. In the interviews, the women tend to ignore their gender and define university and work place as neutral space without gender.

That this is not the right solution for the conflict of being woman and informatics in the same time, this shows the professional insecurity and misguidance of women.

The permanent tension between the strong individual personality and one fade collective self-image must be great. Thus, there is no surprise that women won't feel comfortable in technical profession and very seldom someone gives the back to the exhausted technical profession after some years of work.

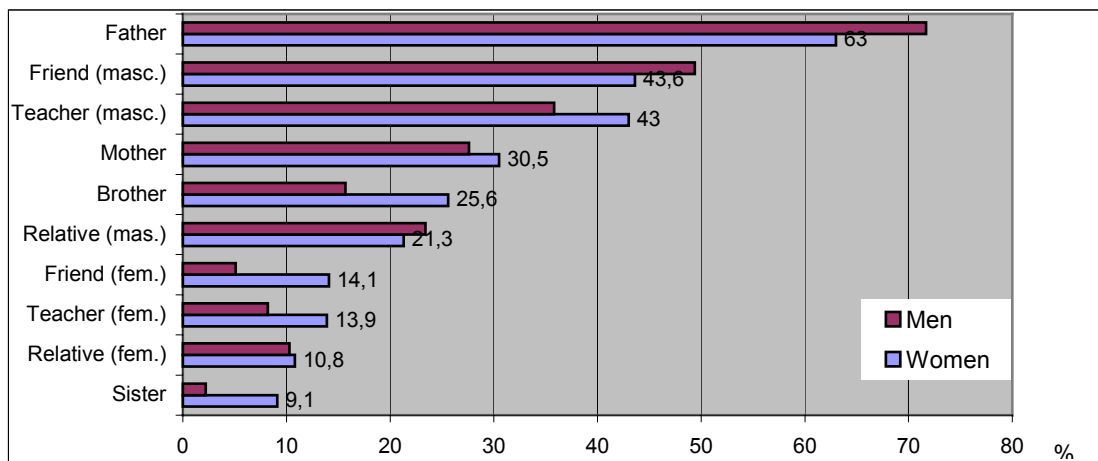


Figure 4 - Persons who fomented the interest in technical matters

#### 4 INTERPRETATION AND CONCLUDING REMARKS

Comparing the gender situation regarding to the science and technology between Germany and Brazil it seems to prevail the common characteristics:

1. in both countries women prefer fields as humanities or health,
2. if the women decide by the technical study or exact sciences, prefer life sciences or one study together with other fields as means or design,
3. pure technical or exact sciences are not attractive studies for women,
4. in both universities the proportion of female students ascended to about one fourth and not changed so much in recent years,
5. in both universities the proportion of women with several technical specialties varies in the wide range from 5% to 64%,
6. in both universities the women elect the technical studies by affection, by the opportunity of the job (more in Germany than in Brazil) and not by the lack of alternatives,
7. in contrast with the current stereotypes, friends and the family are equally important in Germany to elect the field of study, whereas in Brazil, the dominance of the influence of friends with large gap over the family, was clearly noticed.

In Germany as in Brazil is noticed that the survey on gender respectively women call “ *la simultaneidad de integración y marginalización*” regarding to the careers of the highly qualified women. This means that the women participate progressively in the scientific system (integration), but find pushed to the fields less attractive by the men (marginality). Ulrich Beck, a German sociologist, wrote, that in some fields “ women have conquered the boats that are in the sinking process”, those left by the rats (say the men). Consequently not only the participation of women in numerical terms – the objective in equality in the number of gender mainstreaming has already conquered in the German universities, soon will be conquered in Brazil – if not overall in terms of quality – the objective would be the equality in the determining fields for the dynamic of modernization process represented by the technical fields.

#### ACKNOWLEDGEMENT

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