ABSTRACT
This paper explores both how male and female high school pupils (15-16 years old) perceive the engineering profession, and their willingness to pursue a career in this area. A study was performed around a one-day outreach activity, Girls’ Day, organized for the first time in Spain. The study, based on two questionnaires answered before and after the activity, focuses on the differences between groups of female and male students having differing degrees of interest in studying engineering. The educational level of mothers, the presence of engineers in families and perceived family support emerged as important factors influencing the probability of a young person’s considering pursuing engineering studies.

Key Words: engineering perception, engineering studies, education, gender issues, outreach activities.

1. Introduction
Girls’ Day is a one-day event aimed at introducing female students to science, technology and research. The activity, implemented on November 11th 2008, was led by women holding relevant positions in either research or business. Details are given elsewhere [1,2].
A study was performed around the outreach activity. The goals of the study were three:
1. To understand the current views and perception of engineering among 16-year-old high-school students. One of the key points of the study is to find out if students see engineering as a male profession. The altruistic values of engineering were also subject to analysis.
2. To evaluate their intention of pursuing engineering studies. Special effort was taken to analyze gender differences in this variable as well. The aim is to identify possible social, personal or engineering perception differences among those most inclined to study engineering as opposed to those decided against.
3. To evaluate the impact of the outreach activity on student’s perception of engineering and their intention of studying it.

2. The questionnaires
In order to accomplish the study goals, two questionnaires were used:
- a questionnaire collected prior to the activity (hereinafter, the preliminary questionnaire) was targeted not only towards attendees but to all the students of the participating high-schools (both male and female).
- an end-of-the-day questionnaire, carried out immediately after the activity took place (all attendees).
Both questionnaires contained very few open questions. In most cases students had to choose from graded (1-7 Likert scale) answers depending on the degree of agreement with a given statement. Anonymity was guaranteed, and thus the preliminary and end-of-the-day questionnaires were independent of each other, which explains why some questions were repeated in the second form. A translation of both questionnaires can be found on the Web [3].
The questionnaires addressed issues that may be classified within the following areas of interest:
1. Social and Family background
   - Basic demographic data such as age, number of siblings and geographical location.
- Educational level and profession of the mother and the father as well as their degree of familiarity with technology and engineering.
- Engineers in the family.
- Family support.

2. Self perception of student’s personality

3. Academic issues
- How good the respondent considers him/herself to be at technology-related subjects (mathematics, physics, etc.)
- Perception of the difficulty of engineering studies

4. Interest in engineering
- Interest in pursuing engineering studies (at the UZ or elsewhere)

5. Perception of Engineering
- Knowledge of the engineering profession
- Qualitative perception and altruistic values of engineering
- Gender biases regarding engineering

6. Evaluation of the outreach activity
- Direct questions about the development and evaluation of the outreach activity (only in the end-of-the-day questionnaire).

In order to do this, the study classifies high-school students into six different groups: male (M) and female (F) students were divided into three groups according to their agreement with the “I am interested in studying engineering” statement of the preliminary questionnaire. Those with low levels of agreement (1-2 on a Likert scale) are classified as Low interest groups (M1 and F1) as opposed to the High interest groups (6-7 agreement levels), labeled as M3 and F3.

Even at such a young age a big gender gap is detected, as evidenced in Fig. 1. The percentage of females highly interested in studying engineering (F3) is only 8.3%, in comparison to 22.5% of males (M3). This difference is even more marked in those individuals who clearly show low interest in this area, 60% of whom are females (F1) as opposed to 35% of males (M1).

3. Results

The study is based on answers to both questionnaires, combined with a thorough analysis of current demographic and social statistics. 788 completed preliminary questionnaires were collected with a 95% confidence level and a worst-case margin of sampling error of ±3.6%. In relation to the end-of-the-day questionnaires, a total number of 451 were collected with the same confidence level and a worst-case margin of error of ±4.5%.

3.1. Interest groups: Why not study engineering?

One of the research goals was to increase the knowledge of reasons why students choose to study engineering as well as the profile of these students. The final aim is to detect the reasons for the obvious difference between male and female students when it comes to choosing university studies.

Fig. 1. Gender gap detected in the Interest groups expressed in percentages (n: number of preliminary questionnaires).

3.2. Family Background and support

Fig. 2 displays information about the educational level and profession of both the mother and the father and how related these are to technology both for the female and the male interest groups. A significant item is that within the F3 group there is a very high percentage of mothers with higher education levels than the fathers. Additionally, the members of F3 are more likely to have family members who are engineers, a trend confirmed in the end-of-the-day questionnaire.

One of the most significant results of this study has been to highlight how perceived family support in the pursuit of an engineering career has a huge impact on interest groups regardless of gender. Fig. 3 depicts family support (level of agreement with the statement:
“My family encourages me to study engineering”) for the six interest groups. Perceived family support and encouragement is clearly much lower on average for females (2.21 on average versus 3.15 for boys), a difference which is more evidently reflected by the interest groups.

3.3. Engineering profession perception
The perception of engineering was evaluated in the preliminary study according to the agreement with certain statements (Table I). The comparison of the results of the six interest groups shows no relevant differences. Naturally, the greater the interest the better the perception. The only difference is that 60% of M3 believe that the engineering profession leads to high earnings versus only 48% of F3, showing that girls are less financially driven.

Table I also shows statements related to the altruistic values of engineering (statements 5, 6 and 7). Certain studies [4] seem to link female preference for certain professions with the altruistic nature and values of these fields. To simplify the analysis, an aggregate (reversing the last statement, which is in negative form) was computed and tagged as altruistic perception. Fig. 4 reflects that the more altruistic the perception of engineering, the higher the interest elicited; this is even more so for girls, thus reflecting that this is an important point to be addressed in outreach activities.

3.4. Gender bias
Several points of the preliminary study were targeted to understanding the students’ gender bias perception, see Table II. An aggregate (just a summation) of answers to those points was computed to rate how male the profession was considered to be. In general, girls find the profession less masculine than boys do, and the girls more interested in engineering are those who find it less male (Fig. 5).

4. Conclusions
In Spain, like in many other countries and cultures, women choose engineering as a career less frequently than men. Therefore, there is a general need for educators and researchers to understand the factors that determine children's occupational interests and goals. This paper presents a step in this direction, a study based on two questionnaires carried out before and after an outreach activity, the Girl’s Day. The main conclusions of the study are:
1. The educational level of mothers, the presence of engineers in families and perceived family support are important factors influencing the probability of a young person's considering pursuing engineering studies. Therefore, outreach activities should be extended to families, tutors and, perhaps, high-school teachers.
2. Humanitarian and altruistic values are also important for female students and should be addressed in outreach activities.
3. The improvement of the gender perception of engineering, mostly concerning boys, is an important task to accomplish.

The results presented here are only a small part of just the initial ones [5]; the overwhelming amount of data retrieved will have to be further analyzed by the authors.

5. Acknowledgements
The Girls’ Day outreach activity was supported by the IAM (Instituto Aragonés de la Mujer) of the Aragonese Regional Government, the IM (Instituto de la Mujer – Ministerio de Igualdad) and the FECyT (Fundación Española para la Ciencia y la Tecnología – Ministerio de Ciencia e Innovación) of the Spanish Government.

5. References
Fig. 2. Educational level and profession of both mothers and fathers, as well as relationship with technology for female (top) and male (bottom) interest groups. Results of the preliminary questionnaire.

Fig. 3. Family support for the different interest groups. Agreement with the statement: *My family encourages me to study engineering*. Averages for each group shown. The lines join the average points of respondents of each group in the 1-7 scale.
### TABLE I
**WHAT DOES AN ENGINEER DO?**
**STATEMENTS USED TO EVALUATE PERCEPTION OF ENGINEERING AND ITS ALTRUISTIC VALUES**

<table>
<thead>
<tr>
<th>STATEMENTS</th>
<th>M1 (n=111)</th>
<th>M2 (n=123)</th>
<th>M3 (n=81)</th>
<th>F1 (n=277)</th>
<th>F2 (n=146)</th>
<th>F3 (n=39)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Engineering is considered a prestigious profession</td>
<td>27.9%</td>
<td>4.99%</td>
<td>5.6%</td>
<td>45.8%</td>
<td>5.16%</td>
<td>5.9%</td>
</tr>
<tr>
<td>2. Engineering is a creative profession</td>
<td>57.7%</td>
<td>43.1%</td>
<td>80.2%</td>
<td>44.8%</td>
<td>66.4%</td>
<td>82.1%</td>
</tr>
<tr>
<td>3. Engineering is a good option because one can earn a lot of money</td>
<td>14.4%</td>
<td>0.8%</td>
<td>17.3%</td>
<td>8.3%</td>
<td>32.2%</td>
<td>17.9%</td>
</tr>
<tr>
<td>4. I like what engineers do</td>
<td>4.17%</td>
<td>8.5%</td>
<td>2.5%</td>
<td>3.8%</td>
<td>0.7%</td>
<td>0.0%</td>
</tr>
<tr>
<td>5. By studying engineering I will be able to help people</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>6. Engineering makes the improvement of mankind possible</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>7. The reason why fewer girls than boys study engineering is that it does not contribute to the welfare of mankind</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

### TABLE II
**IS ENGINEERING A MALE PROFESSION?**
**STATEMENTS USED TO EVALUATE GENDER BIAS**

<table>
<thead>
<tr>
<th>STATEMENTS</th>
<th>M1 (n=111)</th>
<th>M2 (n=123)</th>
<th>M3 (n=81)</th>
<th>F1 (n=277)</th>
<th>F2 (n=146)</th>
<th>F3 (n=39)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Engineering is more suited to men</td>
<td>41.4%</td>
<td>39.8%</td>
<td>45.7%</td>
<td>53.8%</td>
<td>2.31%</td>
<td>2.26%</td>
</tr>
<tr>
<td>2. Boys like technology more than girls do</td>
<td>11.7%</td>
<td>16.3%</td>
<td>14.8%</td>
<td>7.4%</td>
<td>18.5%</td>
<td>20.5%</td>
</tr>
<tr>
<td>3. The reason why there are fewer girls than boys in engineering is that it is not for girls.</td>
<td>3.14%</td>
<td>3.28%</td>
<td>3.14%</td>
<td>2.89%</td>
<td>77.4%</td>
<td>76.9%</td>
</tr>
<tr>
<td>4. The reason why there are fewer girls than boys in engineering is that girls are not good at technology</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fig. 4. Degree of agreement with the altruistic perception variable for different interest groups. Aggregate results of the level of agreement with the last three statements of Table I. Average response values (from the 1-7 scale) for each group shown.

Fig. 5. Gender bias and interest groups: low, medium and strong agreement with the statement that engineering is a male profession (aggregate). Average level of agreement (of the 1-7 scale) shown.