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## **Gendered Habitus in Engineering: Experiences of Brazilian Students**

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### **ABSTRACT**

This paper discusses the ways in which an 'engineering habitus', that in the first instance presents itself as a predominantly masculinized habitus - because its inclinations, competences and dispositions are homologous to the cultural repertoire traditionally associated with men - may change with the growing presence of women in the field. We draw from the perspective advanced by Bourdieu, in particular the key notions of habitus, capital and field, to explore how particular competences, dispositions and classificatory principles operate in the field of engineering. The study is based on qualitative in-depth analysis of the socialization trajectories of 10 students (five men and five women) enrolled in an engineering degree in a publicly-funded Brazilian university, as well as on quantitative secondary data about the students. This is placed in broader national and international contexts. The socialization trajectories of both women and men studying engineering demonstrate that the experiences of women are patterned by a double bind in cultural repertoires, which affect traditional associations with gender. An engineering gendered habitus not conforming to the stereotypical and dominant masculine is in evidence, as women not only develop competences and dispositions homologous to the traditional masculine habitus, but also show inclinations and affinities commonly associated with femininity. The study advances the hypothesis that the growing participation of women in engineering drives this process, challenging traditional gender divisions and propelling a more flexible gendered engineering habitus in the field. We propose that the phenomenon discussed here deserves further investigation.

### **KEYWORDS**

STEM field, engineers, habitus, engineering habitus, gender, gendered habitus, concerted cultivation, double bind, Pierre Bourdieu



## **Gendered Habitus in Engineering: Experiences of Brazilian Students**

### **INTRODUCTION**

The underrepresentation of women in the fields of Science, Technology, Engineering and Mathematics (STEM) is acknowledged worldwide, especially in engineering. In Brazil, women represented 24% of enrollments in engineering degrees in 2010 and held 17% of engineering jobs in 2011 (EngenhariaData, 2013), although the gap with men is diminishing rapidly (see earlier analysis in Lombardi, 2002). In the more developed economy of the United States, women account for less than one third of both degrees and jobs in STEM areas, with an even lower representation in engineering specifically (National Science Foundation, 2007). These patterns in Brazil and the US do not differ substantially. However, the underrepresentation of women is particularly pressing in Brazil, because the country is heavily dependent on infrastructural development.<sup>1</sup> In the present context of optimism about the national economy, investment in infrastructure has grown, opening up propitious conditions for engineers in the labour market. While the economic stagnation of the 1980-90s forced engineers to search for opportunities out of their engineering field, the picture has now considerably modified, placing engineers in an extremely privileged position.<sup>2</sup> Do changes in the economic position of the field affect gender equality?

We contend in this paper, that the understanding of the socialization conditions in which men and women choose an engineering career is relevant to a broad discussion of economic development, making this a productive focus on the crucial matter of gender equality. The recent expansion of engineering teaching in the Brazilian university system offers a valuable context for this reflection.<sup>3</sup> The growing investment in engineering education has signaled new opportunities for women. How have women fitted in within this traditionally masculine field? What related changes have been introduced to the field of engineering as it profits from national economic development?

To address the phenomenon of how the engineering field may be changing as it expands, in particular regarding the gendering of individuals educated to fit into its normative ways of operating, we developed an investigation based on some quantitative secondary survey data on engineering education and the labour market, and focused qualitative interviews, which form the empirical basis of this paper. Our study concerns engineering students of a recently created public university in the state of São Paulo: the Federal University of the ABC region. The ABC is composed by three cities in the Greater São Paulo area – Santo André, São Bernardo and São Caetano. These have historically concentrated investments of major automobile companies - Mercedes-Benz, Ford, Volkswagen and General Motors. The University was created in 2005, aiming to provide higher education in science and technology; and this is the reason we chose to focus our research on this setting. It allows students to take one of two entry degree routes: the interdisciplinary Bachelor in Science and Technology (BScT) or Bachelor in Sciences and Humanities (BSch). After attending one of these two degrees, formally to be

completed in two years, but taking up to two and a half years to complete, students can opt for more specialized degrees. Thus, students who take the BScT can choose between eight engineering degrees (Business, Materials, Environmental, Aerospace, Biomedical, Energy, Robotics, and Information), six Bachelors of Basic Science (with majors in Mathematics or Physics, for example) or another four Teaching Licenses. Students can opt to follow two degree routes after taking the BScH. This flexible route to a degree leads to trajectories very different from those in the more established Brazilian universities, where students follow only one specialized path. The flexibility has appeared attractive to students, as we will see from our data, opening grounds for experimentation that is particularly important for the young women enrolling at university. Our focus on university students – or academic youth - is appropriate as the individual early socialization processes figure prominently in a person's choice of study. The individuals in this case have not yet fully committed to a professional career in engineering, yet are part of a field of engineering under speedy transformation. We contend that this somewhat transitional phase of the lifecourse presents gender as a more flexible construction, taking shape in tandem with the experiences of professionals in the field. The context is productive for an exploration of gendering processes in the field of engineering.

#### **DATA COLLECTION AND METHODS**

Our sample of interviewees is drawn from students who attended the new university for at least three years with a stated interest to complete a specialized engineering degree. From the ten individuals that comprise our purposeful qualitative sample, seven had completed the BScT and had started their specialized engineering programme, while three others were on the verge of finishing their BScT, having already chosen a specific engineering degree to follow.

The 10 individuals consisted of five men and five women. Eight of them were aged between 21 and 24; the others were 26 and 28 years old. Individuals were recruited via a snowball process whereby a previous interviewee indicates a newer one, our first participant being an environmental engineering student acquainted with one of the researchers. Qualitative in-depth interviews lasting from one to one hour and a half were carried out with the ten individuals. Conversations were audio-recorded and transcribed. Notes on the interaction between the interviewer and the interviewee were taken immediately after each interview. Following transcription, each interview was carefully read through, the key themes in the narrative outlined and the transcribed texts were classified according to each of the six emerging topics of analysis.

Informed by the literature on the theme and our theoretical framework grounded in the work of the French sociologist, Pierre Bourdieu (outlined in the next section), the six analyzing topics defined to structure our interpretation of the interview material were: (a) cultural capital and the influence of parents who are engineers, (b) socialization in school and the inclination for Maths and sciences, (c) the socio-cultural processes of gender production, (d) strategies/ways of relating to the opposite gender in the university and work environments, (e) the meaning of 'being an engineer' and whether this affects broader aspects of living, and (f) trajectories

of university studies and work experiences in the labour market. Following this thematic classification, a summary was completed with conversation material concerning the six topics. (See Table 1 for an illustration focused on the first three topics of analysis).

**Table 1**  
**Summary of interview data on the first three topics of analysis**  
*Cristine, 21, Materials Engineer*

<b>a) Cultural capital and the influence of parents who are engineers</b>	<b>b) School and inclination for Maths and Sciences</b>	<b>c) Making gender</b>
<p><i>Both parents started engineering degrees in public universities. Cristine acknowledges how they fostered her interest in engineering since childhood through special toys, exposure to engineering documentaries and household maintenance jobs: e.g. repairing electric wiring. She also stresses the role played by her mother in the early development of her cognitive abilities and of her father in negotiations of birthday gifts aiming to foster her good academic standard at school.</i></p>	<p><i>States a strong interest for Chemistry and Physics since High school. Says she has internalized the 'nerd' stereotype, and was despised and isolated by other girls in High school. An interaction with a Physics teacher was of key importance to her career choice.</i></p>	<p><i>Loves cars, says she gets along better with male friends, but dances ballet, likes fashion and cosmetics. Says the gender division in her engineering degree is one of the most balanced. However, explains interesting gender divisions on the basis of stereotypes in the interests of student colleagues who take the degree.</i></p>

Data from each transcribed and classified interview were compared with and read in relation to material from the other interviews and a one-page text of these comparisons was written for each of the transcribed interviews, focusing on the topics outlined and any new emerging theme. Following initial analyses, some of the six original topics were regrouped under three major headings which constitute the key analytical sections of this paper.

In what follows we outline the Bourdieusian approach framing our investigation and its links with the broader literature on gender in the STEM field, before moving on to present our findings. These focus on the delineation of the habitus of the engineer, its centrality as a 'masculinized' habitus, which takes different forms in the socialization processes of the men and women participating in our study. We conclude by advancing the hypothesis, to be explored in further studies, that the interiorization of this changing culture experienced by the students is affecting the

habitus in the field of engineering, due to the growing presence of women in the field, who portray a double affinity to both the masculine and feminine gendering habitus.

### **CONCEPTUAL FRAMEWORK AND LITERATURE REVIEW**

Pierre Bourdieu's theory assumes that individuals, and the social groups they form, are situated in a structured and hierarchical social space of positions, determined by the different volumes and structures of the different types of capital they are able to access and incorporate from their positions. Three highly valuable assets that define such 'objective positions' and their related perspectives in the social world are economic, social and cultural capital. Economic capital refers to family income, salary, assets and any other source of financial resource the individual, or a group of individuals, can rely on. Social capital derives from the stock of social relations and acquaintances an individual is able to accumulate due to her social origins, and institutions or social spaces where her life trajectory takes place, and the status and prestige, possibly drawn from this, belonging to a particular family, social group or neighbourhood. Cultural capital derives from both the diplomas an individual has accumulated through his trajectory within the formal educational system and the intellectual and cultural dispositions, competences and tastes incorporated through the implicit and continuous socialization within the family, community or social class the individual belongs to since birth (Bourdieu, 1984).

The structure and volume of these three types of capital - that is, the 'objective conditions' that define many of the chances and perspectives one can be presented with in social life - are internalized through the continuous socialization of the individual. The internalization is expressed under the form of a set of competences, inclinations and tastes that shape a subconscious - or unconscious - principle of generation and unification of practices in the home, in schools, in the consumption of culture, in social relations, and so on. In other words, a general attitude towards diverse dimensions of life, a specific manner of living and conceiving the world results from the subjective internalization of the individual's objective position in social space. Bourdieu developed the concept of habitus to refer to this phenomenon: the specific and taken for granted manner of living.

In much of his work, Bourdieu argues that social class is the main category that structures the social space of positions (where the individual is placed on the social map) and dispositions (an inclination to do or feel things in certain ways), the space of the objective conditions and their correspondent habitus. In his studies on the sociology of education, for example, Bourdieu demonstrates how the homology between the requirements of the educational system, predicated on the habitus of middle and upper classes - that is, the familiarity with the usage of formal language and the continuous and implicit intergenerational transmission of cultural capital - accounts for the educational inequalities between social classes. This leads to lower-class students having poorer performance and shorter trajectories in the educational system (Bourdieu & Passeron, 1970).

In his major treatise, *Distinction* (Bourdieu, 1984), which is heavily-based on statistical work and qualitative accounts of cultural consumption, Bourdieu

formulates some detailed divisions of the social space of positions and dispositions. In a later study on the structure of the academic field, *Homo Academicus* (Bourdieu, 1988), he goes further into dividing the social space with deeper specificity, proposing within the academic field a refined division according to domains of knowledge and professional areas. In *Homo Academicus*, Bourdieu demonstrates how Faculties like Law and Medicine differ in many aspects – social origin, economic capital, political stances, presence in high-ranked public posts and time dedicated to research – from Faculties of Arts and of Sciences. From the comparative analysis of these differences, he argues that Faculties of Law and of Medicine are characterized by a habitus of attachment to the economic and political order, from which professional accomplishments outside the academic world, as well as political and symbolic credentials, are more relevant than scientific capital for academic disputes and legitimization. On the other hand, Faculties of Arts and of Sciences are characterized by a habitus more inclined to the contestation of the economic and political order, with a greater value attributed to science and research rather than to non-academic activities. Although it is far from our intention and ability to do a STEM field analysis here, this kind of work can illuminate our understanding of the engineering field, characteristically closer to those of Law and Medicine, as described by Bourdieu. We expect the orientations of students in engineering to show greater affinities to the prevailing economic and political orders.

In *Les Héritiers*, Bourdieu & Passeron (1964) argue, based on statistical evidence, that gender is an important social dimension to the definition of the knowledge areas and university courses one chooses to pursue. However, Bourdieu's grasp of the workings of gender divisions is not particularly helpful. We draw from some of his critics to deal with this matter.

Criticisms have addressed Bourdieu's narrow view of sex identity, particularly salient in his work on masculine domination (Bourdieu, 2001). Bourdieu is criticized for presenting gender as founded on the constant sexual differences of bodies, 'as given, basic and common across time and cultures' (Silva, 2005, p. 92. See also Adkins, 2004; Skeggs, 2004 and Lovell 2000). The rich appropriation of Bourdieu in academic feminist analyses has promoted a seminal reflection on the relations of gender and social classes for a variety of empirical data and situations (Reay, 1998; Lawler, 2000; Skeggs, 1997; Walkerdine and Lucey, 1989; Silva and LeRoux, 2011). Understanding the interplay between gender and social class was also one of the aims of *Class, Culture, Distinction* (Bennett et al., 2009). In this study, it is argued that to better explore the logics of cultural distinction in the contemporary UK, class, age, gender and ethnicity must be considered as social dimensions of key relevance to the transmission and incorporation of cultural capital, and to the shaping of the habitus. We follow these elaborations in our analysis.

We also take a perspective similar to that of Bourdieu in *Homo Academicus* (1988), in order to delineate – guided by the exploration of our empirical data - the competences, inclinations and dispositions that shape the specific engineering habitus in the field of engineering. We show that in this field a strongly gendered habitus prevails, associating competences, inclinations and dispositions to the social

and cultural traditional repertoire of masculinity. We demonstrate how socialization experiences in the family, school, peer groups and university are associated with age, class and gender, to constitute a particular field gendered habitus – evident among both the men and women who participate in our study.

We show that the socialization instances pertinent to the shaping of the engineering habitus are similar to those presented in the literature concerning the presence of women in STEM areas. These find the influence of parental educational level and pre-college preparation and identification to Sciences and Maths at school strongly relevant (Carlone & Johnson, 2007; Eccles, 1994, 2007; Hugues, 2010, 2011). However, we have not adopted the conceptual frameworks generally mobilized by these studies as, for instance, Eccles' (2007) expectancy value model of career choice or Carlone & Johnson's (2007) framework of science identity formation. According to these conceptual frameworks, 'cultural' factors - parents' educational level, gender roles and teachers as socializing agents – mix with supposedly 'individual' abilities, perceptions and experiences to define a lesser or greater capacity of the individual to author a successful identity in STEM fields. Our approach differs from those of Eccles (2007) and Carlone & Johnson (2007). We hope to expand on their lead, but we do not acknowledge the 'individual' abilities, perceptions and experiences as birth gifts or assets that would help some individuals to author an identity in STEM areas, while failing to do so with other individuals.

Guided by Bourdieu's perspective, we regard the distinction between 'cultural' and 'individual' factors as counterproductive. The main challenge of research in the area of STEM should be to understand how 'objective conditions' - social and cultural factors and experiences - are internalized by individuals in the form of their views of the world, their dispositions, inclinations and competences - in one word, their habitus. The challenge is to understand how the habitus leads them to pursue a career in the STEM field, especially when this field presents a dominant habitus apparently incongruous with one's common gender position, as is often the case with women (McNay, 2000).

In this sense, Bourdieu's perspective seems to offer an innovative and productive theoretical and conceptual framework. First of all, it does not operate a division between 'cultural' and 'individual' factors. Second, the focus on the internalization of objective conditions, under the form of subjective dispositions, calls for the need to reconstruct and describe the sociological mechanisms and dynamics through which socialization experiences shape the inclinations, competences and dispositions of individuals – our interviewees - towards the constitution of a particularly gendered engineering habitus. Third, and our more innovative contribution, by considering the patterns of young women and men in their relation to the field, we advance the hypothesis of the emergence of changes in the engineering habitus. This field habitus appears marked by a cleavage, where the predominantly masculine delineation of this field has been challenged by increasingly more fluid gendering imprints due to the growing presence of women in engineering.

**ASSESSING THE MATERIAL: THEMATIC ANALYSIS**

In 2011, 94% of undergraduates at UFABC were enrolled in the BScT entry level degree. (The BSCh was then still under implementation). Men accounted for almost 70% of undergraduates. Whites represented 69%, while blacks and mulattos added up to 22%. (Mulatto refers to racially mixed individuals who don't identify as whites nor blacks. At UFABC 18% of undergraduates were classified as mulattos in 2012). Regarding parental education, 40% of students' fathers and 39% of their mothers were holders of a Bachelor's degree (UFABC, 2012).

In Brazil, private high schools integrate a key element in the social reproduction strategies of the middle classes. While 12% of Brazilian high school students are enrolled in private schools (INEP, 2010), the percentage of students attending publicly-funded universities—traditionally acknowledged as the best universities - who had received private school education is considerably higher.<sup>4</sup> The student body was thus predominantly male, white, middle class, and privately educated. Our research participants' recruitment method, based on informal networks of interviewees, appears to have led our sample to over-represent whites, students whose parents (mother and father) hold a Bachelor's degree and those educated in private schools. Informal networks are based on close ties, friendships and mutual trust. Therefore, they are most likely to join individuals that share the same or similar social class and racial backgrounds. Only one of our interviewees is mulatto, only one individual has neither of her parents holding a degree and only one studied in a state-funded high school. We need to bear this in mind in our analysis. To compose the sample, we made an effort to select men and women taking degrees that were strongly gender-marked and also those more gender-balanced. Among students in the BScT, men strongly outnumber women on a ratio of 68% against 32%. This proportion reinforces the association between STEM fields and male predominance, since, for the more recently created BSCh, the ratio of men is 56% against 44% women. Regarding the engineering degrees students may choose after the BScT, we observe that some of them are notably less gender-marked than others (see Table 2).

**Table 2 – Gender division by engineering specialties: numbers of male and female students out of total numbers enrolled**

<b>Engineering Degrees</b>	<b>Undergraduate male students number</b>	<b>Undergraduate female students number</b>
Biomedical Engineering	18	21
Engineering of Materials	55	49
Aerospace engineering	41	7
Robotics engineering	115	13
IT engineering	27	2

Table 2 shows that women outnumber men in Biomedical Engineering, and are proportionally almost equal to men in Materials; but in Aerospace, Robotics and IT

men overwhelmingly predominate. While maintaining segregation in certain areas, the flexible curriculum makes women’s entry into particular fields more attractive. We shall see that such differences are constantly remarked upon by our interviewees, although they have been scarcely explored in the literature. Table 3 gives the ages and degree titles of our interviewees.

**Table 3 - Interviewees, ages and degrees pursued**

(pseudo) Name	Age	Engineering Degree
<b>Cristine</b>	21	Engineering of Materials
<b>Carlos</b>	26	Environmental Engineering
<b>Alex*</b>	23	Engineering of Materials/ Business Engineering
<b>Andre*</b>	23	Business Engineering/ Aerospace Engineering
<b>Brenda*</b>	24	Robotics Engineering/ Environmental Engineering
<b>Marco</b>	23	Aerospace Engineering
<b>Royce</b>	23	Robotics Engineering
<b>Maria</b>	28	Business Engineering
<b>Fran</b>	21	IT Engineering
<b>Diana</b>	24	Business Engineering

\* Andre was undecided about whether to take Business or Aerospace Engineering. Alex and Brenda chose to take two degrees concomitantly.

The thematic analysis that follows focuses on the meaning of being an engineer in order to delineate the habitus specific to the field. We attend to the narratives positioned in terms of gender: accounts of masculine and feminine interjections in social trajectories and in the field of study

**‘Being an engineer’: the specific habitus of engineering**

References to what it means to be an engineer preoccupied participants as a recurrent theme in the course of our interviews. They used the interview as a reflexive opportunity to consider implications concerning their rapport with their studies, the job market and even with personal relationships. We were interested in the theme, of course, but through prompting it, it evolved into a major explicit concern. Participants offered accounts of dispositions, competences and inclinations developed since childhood, which had been deepened and intensified since entering university.

The accounts form a narrative about a specific engineering habitus. They compound the basic requirements for defining the Bourdieusian concept of habitus:

1. The dispositions and competences outlined are not ‘natural’: they were developed and incorporated through the socialization experiences of the life trajectory of the individual.

2. They operate as a principle of vision and division of the social world, that is, they establish the criteria according to which an individual sees himself and the people who share this habitus with him in opposition to the people and groups that do not share it.
3. This system of dispositions is transferrable to diverse domains of life, operating as a principle of generation and unification of practices within different domains.

Regarding specific dispositions and competences presented, all the interviewees explain that being an engineer means considering processes and phenomena under a strictly 'rational', 'objective' or 'cold' manner, being able to 'calculate' or 'quantify' virtually everything according to highly 'logical and mathematical reasoning'. Such competences are presented as being developed through preference and feeling of ease with the subject they have had since early schooling, in particular an affinity towards sciences and Maths, deepened and intensified through their university education and training.

Interviewees frequently regard engineering as one of the 'most challenging' or 'hardest' BSc degrees. For instance, comparing their experience to that of high school friends who have taken other traditional degrees (Law and Medicine); two interviewees stated that their degree is much harder because of the level of reasoning it demands. Asked how she pictures her future within the next ten years, Brenda expects this deep amount of effort to pay off when she graduates: 'I hope to get a nice salary, because our wrestling with studies here is no joke.' Students remark that only BSc degrees in Mathematics or Physics would present the same level of complexity. Nonetheless, they often draw lines between themselves and other STEM professionals, especially those doing 'basic science', stressing their own straightforward inclination, as opposed to the abstract and theoretical inclination of, for example, mathematicians. Explaining the difference between a Calculus class with a professor who's an engineer and with one who's a mathematician, Royce says:

The engineer will say 'Look, that is the problem, now let's see how we solve it'. But the mathematician, no, he wants to explain how the problem is, why it's like that, and so on... The engineer will simply solve it and say 'Well, if you want further details and information about this, look at this book, at this page'.

Considering things in a 'rational' and 'objective' manner is the prerequisite for the superior 'problem-solving' disposition interviewees claim engineers to have, giving them the capacity to yield solutions and results to a wide array of corporations and branches of economic activity due to their pragmatic and straightforward inclination. This inclination is presented as the key principle of the vision and division of the social world, as what distinguishes engineers in competition with other professionals for the most valuable positions in the job market. Having such a valuable asset in this social competition for revenues and status seems almost inseparable from having incorporated the desire to be successful in the competition. Among our participants only Carlos wants to pursue an academic career, while the

others either don't mention this possibility or discard it due to its low financial rewards.

The dispositions and competences attached to being an engineer operates as a principle of distinction and division not only between traditional professions, or professions other than engineering in the STEM field, but also between larger areas of knowledge. Hence, interviewees see themselves as very distinct people from those who pursue studies and careers in the Humanities. Cristine states:

... when you start to analyze things in a different way, it all gets straightforward...; you get to be a straightforward person. You get an exercise to do, it's hard to say it to a person that comes from the Humanities, but there's only one single answer! For you [assuming the interviewer is from the Humanities] there's a bunch of possibilities, but for us it's straightforward, it's A+B. That renders life easier; you get to see things in a pragmatic way.

The rational and straightforward system of dispositions that characterizes engineers also appears to be involuntarily transposed to diverse domains of life, leading to a general and taken for granted attitude which seems to be unconsciously reproduced within rather different moments and situations. According to two interviewees, these rationalized dispositions are transposed even to that domain which, by definition, cannot be rationalized: love relationships. Marco says:

I think sometimes I treat non-analytical issues in a pretty analytical manner, for instance, love relationships... Some things shouldn't be analysed, so that's a negative side... but on the other hand, it gives you a clear view on discussing personal life issues, just like: 'Well, that's it, let's pin down the reasons, the relations of cause and effect'... So, actually, all this scientific investigation can provide you with a clear view on your decision-making process, your choices in life, your ways of seeing the world, but it can also turn to be negative, because you end up with a desire to rationalize everything, and that's not possible!

In the narratives, however, the dispositions of logical reasoning, objectivity and calculus, as well as pragmatic and straightforward inclinations, are generally associated with the cultural repertoire of men. Women are more commonly identified with sensitivity, emotions, subjectivity and ambiguity. When asked about the reason for male predominance in the engineering field, interviewees formulate this as a traditional division between the genders' cultural repertoires, eliciting the masculinized characteristics of the engineering habitus.

Some participants attributed the masculine drive towards logical reasoning, objectivity and so forth to an essentialist or naturalistic condition in men, while others linked it to culturally established differences between men and women. All students observed that since early schooling, women were generally inclined to the Humanities and Biological areas, while most of those interested in Science and Maths were men. Fran states: '(...) I guess women are much more subjective than men, women are... I don't know how to explain, but men are logical, they are just

like 'Yes or No'. Alex follows the same track, reporting that '(...) men are colder than women; maybe women explore more their human side'. Andre, Marco and Brenda trace this back to childhood experiences and the differences between toys and games of girls and boys. Royce offers the most extreme statement on the engineering habitus as a masculinized one:

Perhaps the male mind - I have no theoretical grounds for this - but perhaps it has a feel of ease with Science and Maths, with reasoning, with objectivity, such as engineering, so then, perhaps, engineering is composed of more men because of it. So when you have a woman in engineering, she ends up having male characteristics in the way she thinks, in the way she acts... I do not know if she acquires these characteristics from the men around her or if she has a male mentality.

Engineering courses appear to have different styles of gender-marking, depending on the greater or lesser presence of women among their student bodies. When confronted with this numerical difference, it is interesting to note that interviewees frequently attribute the lesser presence of women in specialties such as Aerospace, IT and Robotics engineering to the fact that these degrees demand more complex calculus and mathematical competences. Besides, they usually state that such areas involve interests and tastes better identified with men such as dealing with mechanics, engines, airplanes and robots.

In sum, the engineering habitus is commonly perceived as a masculinized one but engineering degrees are seen as presenting diverse styles of making masculinized gender, according to the competences and interests they are associated with. Hereafter, we must focus on the sociological mechanisms and dynamics through which socialization experiences narrated by the interviewees have shaped this masculinized habitus both among the men and the women in our study, and their association with engineering degrees where gender is marked differently.

### **The shaping of the engineering habitus among men**

Four out of the five men in our sample have fathers who are engineers. This high level of professional heredity provides us with a unique opportunity of delineating how the specific cultural capital from the field of engineering are transmitted through the implicit and continuous socialization of fathers with their sons, that is, under the form of children joining their fathers in tasks they generally undertake, or even simply by playing with them while growing up. Within the Bourdieusian perspective, through these experiences, the future engineers incorporate their objective conditions of socialization in the form of competences (basic knowledge of science and calculation), dispositions (of pragmatic and straightforward reasoning) and inclinations (interest in technology and technical processes) that would produce advantages outside the formal educational system, to be later capitalized within it, and that also prefigure career choice.

Son of an engineer of the automobile industry, Alex reports that his father has a 'handyman' profile and that, as a child, he usually followed him when fixing things at home and in the houses of relatives. He says his father stimulated his 'logical

and numerical' abilities and he links this to the feel of ease he's always had with Sciences and Maths at school in opposition to his dislike and difficulties regarding the Humanities. The same goes for Royce, son of an electronics engineer, who accompanied his father while installing and repairing their house's electric system, fixing cars and home appliances, and enjoying when his father made him little demonstrations of electric circuits. He says he has never doubted he would be an engineer and that he's always been much more 'attached' to Sciences and Maths than to other subjects. From 14 to 16 years old, he joined an industrial apprentice educational program, where he got the chance of having a trainee experience in the company his father worked in. Carlos, son of a surveyor engineer, says his father had little influence on his career decisions. However, he reports that he used to watch documentaries on technology together with his father, who liked to give him extra explanations on how the devices and mechanisms pictured in the documentaries worked. Marco reports that since the age of four, he has explored folders and archives in his home PC, saying that as a child he sometimes 'messed up' the PC by doing so, which presented no problem, since one of his uncles worked in a computing company and was able to easily get it in order. This happened in the early 1990s, when PCs were far from common in Brazilian homes, even among wealthier families. Son of an engineer who owned the company he inherited from his own father, he says that since the age of five, he used to take summer jobs in his family's business. By that early age, his task was simply filling up the crushing machine with paper that would later be used to encase the products sold, in order to soften the impact between them and the boxes in which they were transported. Despite the simplicity of the task, it placed Marco in contact with knowledge about basic Physics processes from a very tender age. Regardless of a troubled trajectory in school (diagnosed with ADHD - Attention Deficit Hyperactivity Disorder), Marco always had a drive for Maths and Physics. As a teenager, he even won some Maths Olympics organized in his school.

In the cases of both Marco and Alex, their families are composed not only of fathers who are engineers but also of uncles and cousins who have pursued the same professional trajectory.<sup>5</sup> Both students report that on extended family gatherings, it's normal to talk about engineering jobs, the job markets and technological innovations. Both of them enjoy these conversations that seem to take the form of a socialization moment that celebrates the entrance of the 'former' adolescents into the group of adult men within their family.

The only interviewee whose father was not an engineer was Andre. But even in his case, it is possible to see how a form of playing as a child, supported by the grownups in his family, contributed to the development of the required competences and dispositions to pursue the career of engineer. Adults in his family used to separate out for him old home appliances, because he liked to take them to pieces to see 'how it was like inside'. They also taught him how to use screwdrivers to do so. Andre said 'Physics was love at first sight, because I liked that way of thinking and seeing things'. Nevertheless, he is the only one of the five male interviewees who also had strong interest in the Humanities. He said he read a lot as a child, an interest fostered by a psychologist aunt. Andre said he was considering enrollment in a Business Engineering degree after his on-going trainee

experience, rather than a 'technical' engineering job, since Business Engineering offers a macro view over processes, including a 'human' side inclination for dealing with and managing a team of different people.

In these socialization practices we identify what Annette Lareau (2003) refers to as 'concerted cultivation', according to which middle- and high-class parenting practices endow children with a set of experiences which are mobilized into extra advantage in the formal educational system, as well as in their later engagements in work and institutional environments. When the parents of our participants involve them in the experiences we have just described, they are practicing a very particular kind of 'concerted cultivation'. First of all, they are shaping their son's affinity with the cultural repertoire traditionally associated with a technical operational masculinity. But it's not only a matter of gender. For the shaping of the cultural repertoire of men operates as a conduit to build a set of competences and dispositions, homologous to the dominant engineering habitus, that not only endows them with extra advantages in the formal educational system, but also predisposes them to choose a career path socially valued in the Brazilian contemporary context and which is likely to lead them to reproduce their middle- and high-class positions.

Besides this parenting work, we must also acknowledge the internalization of other objective conditions that framed the socialization trajectory of these individuals and rendered possible their access to an engineering degree in a state-funded university. All of them had had private education. Besides, all of them are fluent in English as a second language. Alex, Marco and Royce are also studying German, allegedly because of the centrality of German companies in the world of engineering. Among all the University's undergraduates, 86% are fluent in English, against only 2% in German (UFABC, 2012). The objective socialization conditions of these three interviewees render it possible for them to acquire a very rare asset for their chances in the competition for socially valued positions.

### **The shaping of the engineering habitus among women**

Understanding how the masculinized habitus of the field of engineering among women differs from that delineated for men, is a major challenge for our study. As in the case of men, we observed that the shaping of this habitus also flows from early socialization experiences within the family, school, peer group and technical schooling. Nonetheless, these socialization experiences lead women into an important double bind regarding the traditional cultural repertoires of both men and women. The women we interviewed engaged in this field present a particular kind of habitus, composed of dispositions, inclinations and competences of the traditionally masculinized engineering habitus, along with inclinations, interests and dispositions generally associated with the traditional cultural repertoire of women. This mix challenges the dominant engineering habitus to absorb more flexible characterizations of gender, as women's participation in the field increases, and women's performance outpaces men's (In 2011 at the University studied, women's average grade outperformed men's by almost 10% - UFABC, 2012).

Cristine is the only woman in our study whose parents are engineers. Her mother is a civil engineer who, however, never practised the profession, being a bureaucratic civil servant. Her father dropped out of a mechanical engineering degree during his final year, later taking an IT BSc. Cristine says she always joined both her father and mother in doing maintenance and repairs in their home. She also shared her father's passion for cars, helping him to wash and fix their own car. At the age of five, she said she knew all the tools he used for such tasks. Her mother stimulated her interests, giving her, early on, a toy called 'Little Engineer', composed of small wooden bricks used to build structures. Predictably, Christine was inclined to Physics and Chemistry at school. Since adolescence, she's got along better with men rather than women. She states she has a 'male mind': she is straightforward and shares some of men's typical interests, as her taste for cars illustrates. However, her socialization experiences have also made her incorporate typically female inclinations and dispositions. She has been practicing ballet since three years old. Nowadays, one of her hobbies is being a cheerleader in the University team. She says her grandmother, who was always dressed up, influenced her taste for wearing makeup and being into fashion, and she could tell, as a child, how people react to good appearance. She says she had considered taking a career in Fashion, but a male Physics teacher advised her to get into the STEM field and to pursue her fashion interests as a hobby.<sup>6</sup> That's what she did: she states that taking care of her appearance works as a way of relaxing and compensating for the pressures of the engineering degree.

Brenda is acquainted with Cristine and shows the same pattern of double affinity to the traditional masculine and feminine cultural repertoires. She likes cars – she used to watch Formula 1 with her father as a child – she has always preferred to get along with boys rather than girls, for she doesn't like 'girlie's gossips and affectation'. She has always had a feeling of ease with Sciences and Maths. However, she's also highly interested in fashion, saying that these days lots of women who take engineering like to dress up.

Diana's family descends from traditional rural politicians of the Northeast, the poorest area in Brazil. She says her father is still part of that typical 'macho' culture. However, she explains that this sexism doesn't influence the career decision of the women in her family, but is targeted at their freedom to experience sexuality, especially as adolescents. She says her grandmother was the first woman in the Northeast to get a BSc in Physics. This grandmother had an important role in developing her affinity with the STEM area. When she was a child, the grandmother used to train and deepen her mathematical competences in 'private lessons' she used to give to Diana. Thus, although she studied in a traditional high school that emphasized the Humanities, Diana was inclined to Maths. As with Cristine, her Physics teacher was also the one who suggested she took up a career in STEM. Following this advice, she chose Business Engineering, because it was the most 'multidisciplinary' engineering: something that would suit the multidisciplinary competences she built as a student attending schools that focused on Humanities, despite her inclination towards Mathematics and Sciences.

Maria, in turn, had never thought she would enroll in an engineering degree. Like Diana, she had studied in schools that focused on the Humanities. However, after graduating in Communication, she was advised to undertake Business Engineering both by a professor in a MBA she took and by a Human Resources manager who conducted a recruitment process, where she did not get the job. Still reluctant to take an engineering degree, she enrolled to do Logistics, but considered it wouldn't meet her needs for professional growth, shifting then to engineering. Maria was attracted to engineering by the elements of distinction it holds in the professional world. This particular condition placed her as the only interviewee to criticize what she sees as the 'narrow views and thoughts' of engineers. She also reports the difficulties she had in working in groups with other engineering students when doing joint academic work. On the other hand, she acknowledges that, since starting the engineering degree, she has developed a pragmatic inclination that renders her 'more focused on goals' and also enhances her mathematics competence. Despite her criticism, she seems to be incorporating the habitus of the field, there including the elements of distinction it holds in the competition of the professional world. What were the socialization experiences that mediated her transition between the Humanities area and the field of engineering? The question is important for assessing the different ways in which the field of engineering incorporates elements commonly associated with the feminine gender habitus. Fran's story has similarities with Maria's insofar as her affinity with the field developed later on in her lifecourse, propelled by agents outside the family. Fran did not have experiences within her family that could have shaped dispositions and inclinations towards engineering. Fran had a different socialization trajectory from the other middle-class interviewees that equally led, however, to the shaping of an engineering habitus.

Fran was always close to her mother - a high school dropout working as a baby sitter - and was never close to her father, a car mechanic, due to emotional problems towards him. As a teenager, she took part in an informal network of borrowing 'cute', 'girlie's' books, like the famous series 'A Princess' Diary'. How, then, could she have developed the dispositions and inclinations of the masculinized engineering habitus? Fran herself states she doesn't know why she is 'out of the normalcy curve', for being inclined to Maths and for being about to begin the IT engineering degree, following completion of the entry BSc. (As we noted earlier IT is the degree with the highest proportion of men.) She cannot consciously locate the socialization experiences that have shaped her dispositions and inclinations towards engineering. Nonetheless, the interview provides some understanding about that.

Fran's family had an income level much lower than the middle-class families of the other interviewees. She had studied in a very poorly resourced state-funded school of a poor region close to the city of São Paulo. She says teachers generally missed classes, leaving students on their own to wander around the school. However, she recalls that the Maths teacher was one of the few teachers committed to the students. She said she learned a lot from him, with dedicated tutoring near the period when she enrolled for selection to a much better ranked state-funded high school. Afterwards, she got the chance of taking a Computing technical course at

that high school. She was one of the few girls doing computing, which she loved and said that relating to boys turned out to be easier than to girls, since boys didn't have the 'silly rivalries' that existed among the girls. After this technical course, she decided to pursue IT engineering.

Fran is the exception in our sample. Her case reveals socialization mechanisms through which underprivileged individuals may acquire access to, and incorporate the habitus of, socially valued professions. She is what Bourdieu would call a survivor from the super selection imposed by the educational system on poor students. Despite poverty, her mother projected onto Fran the future she hadn't been able to pursue: focusing on education to get a Bachelor's degree. Fran's mother provided her with emotional support to withstand the difficulties and uncertainties that underprivileged students face in their trajectory within the educational system. Throughout the interview, Fran reported five occasions when she turned to her mother in tears due to failures or fears in exams. Always following her mother's advice, she started to develop her mathematics competence and through the influence of a Maths teacher at the end of her middle school, managed to get admitted to a better high school and was socialized into a predominantly male field due to the Computing technical course she took during high school.

Cristine, Brenda and Diana could count on the particular form of 'concerted cultivation' we observed among the men in our sample. However, in Fran's and Maria's cases the inculcation of dispositions and competences homologous to the engineering habitus occurred through socialization experiences they underwent outside the family context. This evidences the fact that such a particular form of 'concerted cultivation' is certainly important to the shaping of a field habitus in an individual. These cases diverge from the emphasis on the family as reproducer of advantages, and show the relevance of the support of other agents for social mobility and, crucially for our argument here, for the development of a field engineering habitus in women, as part of a public policy to foster economic development. This is particularly pertinent to the Brazilian case where the presence of women in engineering is growing.

It is important to note that for all women in our study, the engineering habitus is shaped by a double affinity to the cultural repertoires of both men and women, flowing from the dual nature of typical gender socialization experience. For instance, Cristine shares her father's passion for cars, but is also highly interested in fashion due to her grandmother's influence. Fran is taking the predominantly male course of IT Engineering but also has a taste for 'little girlie's things'. This duality of socialization experiences shows co-presence of the cultural repertoires traditionally associated with men and women. Women can obviously calculate, be pragmatic and develop interests for technology, mechanics, while men can be sensitive and caring, and have a strong interest in subjective matters, as well as in fashion and beauty. Exposure to socialization experiences within the family, as well as from other agents like school teachers, or indeed from broad culture, generates varied imprints of gender in one's habitus.

## CONCLUSIONS

Our investigation of the bearings of early socialization in the gendering of those engaged in engineering education indicates a process of 'concerted cultivation' derived from the immersion of children – girls and boys - in practices akin to the field of engineering, where affinities for 'rational' and 'straightforward' systems of dispositions are found. The academic students showed dispositions operating as principles of vision and division, establishing criteria for their own positioning in the university curriculum – choices of further specialist engineering degrees - and their aims in the labour market - seeking distinction based on financial and status rewards. These dispositions also shape the ways they see other people, in distinct professional fields like Law, Medicine and the Humanities, which do not suit their envisaged career paths.

This study expands from Eccles' (2007) and Carlone & Johnson (2007)'s accounts of the authoring of an identity in STEM areas as a mix between 'cultural' and 'individual' factors. Our study, drawing on Bourdieu's perspective, shows that the building of a career in engineering is better elucidated as the internalization of objective conditions of socialization under the form of a set of dispositions and competences fitting with a predominantly masculinized habitus, which informs the vision and division in the field. Yet, the growing presence of women in the field of engineering appears to challenge the dominant masculinized habitus.

While we see that the students share the principles of distinction of engineers in the professional market in their desires to be successful in terms of financial assets and status, the growing presence of women in the field appears to have introduced more flexible characterizations of gender, via the double affinity women present with traditionally defined matters of gender. The very existence of a more flexible academic curriculum for the engineering degree in the University studied is a mark of some fluidity, welcomed by, and contributing to, the growing presence of women in some specialized courses. This has the potential to affect the field of engineering as a whole, bringing about greater gender equality and positive implications for economic development. We contend that important changes of habitus in engineering are being delineated, which account for newer gender markings in individual's profiles in evidence in this study.

## ENDNOTES

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<sup>1</sup> In 2007, Brazil had only two engineers for each 10,000 inhabitants. Proportionally, South Korea and China had respectively eight and five times more engineers than Brazil. Even some Latin American countries, like Chile and Mexico, had more than double the Brazilian proportions (EngenhariaData, 2011).

<sup>2</sup> During the stagnation period, not finding jobs in their field, engineers moved to managerial positions in the services industry, in particular into banking. In 2000, only 30% of engineers worked in specifically engineering positions. Following sustained economic growth, this grew to 38% in 2009 (IPEA, 2012). While roughly only 8% of the Brazilian economically active population achieve earnings that are

between 7 and 20 times the minimum wage, engineers in this income bracket amount to almost 60% (EngenhariaData, 2013).

<sup>3</sup> In the first decade of this century, the number of places for undergraduate students at national publicly funded universities grew by 265%. Undergraduate places in engineering increased by 422% (EngenhariaData, 2013).

<sup>4</sup> At UFABC (2012), 52% of undergraduates had been privately educated.

<sup>5</sup> Though the typical Brazilian middle-class home is composed of a nuclear family, uncles, aunts, cousins and grandparents who live in separate homes tend to play important socialization roles in children's lives. Family gatherings are generally the occasion for discussion about major decisions.

<sup>6</sup> Maths or Physics high school teachers frequently play some key role in pupils' decisions to pursue a career in STEM. This was also the case for other students in our sample. Nevertheless, this role is not constitutive of the institutional design of Brazilian high schools: students have generally more than 10 different teachers in each high school year and they do not spend more than two hours a week with each one of them, in classes that range from 30 to 50 students.

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