

Gender Studies of IT: From Equality Strategies to Epistemological Issues

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Abstract

Studies on Gender and IT have evolved in the last decade from a quantitative and equality perspective to a more profound analysis of the subjacent causes of that situation. In this article I will start with a brief review of the so-called 'women into IT' approach followed and the most important critiques. Secondly, I will examine 'gender and IT' studies from the feminist constructivist approach, which involves the assumption of the 'co-construction of gender and technology'. Because this claim is very general, I will try to establish an analytical framework to proceed with the study of the gender-technology relation from a constructivist point of view. To that aim I use Sandra Harding's multi-level theory of gender and how these levels can be analyzed with relation to information technology, both at a general level and in case studies of particular IT developments. In the last section I propose to broaden the scope far from the design of concrete artefacts to the study of the theoretical foundations, paradigms and discipline traditions, that is, ontological and epistemological issues. I will illustrate this with an example from Artificial Intelligence.

Introduction: Women, gender, ICT and IT

Literature on women and information technology (IT) is very wide in scope. If we consider it together with the more general label of 'women and ICT' (Information and Communication Technologies), the amount of literature is enormous. ICT refer not only to computation technologies but also to communication technologies (especially the Internet, but also other communication technologies such as mobile telephones). Since the broad diffusion of the Internet in the last decade, the topic about access and use of new communication technologies has become an issue in many countries, what is widely known as the 'digital divide' problem (Castells 2001). The 'gender digital divide' refers to the difference in access and use of ICT of men and women, and it has been widely documented (see Sørensen 2002).

The most relevant feature of the gender divide is that it has been getting smaller in recent years, especially in the most developed countries: an OECD report shows that in Finland, the United States and Ireland, women's access is (slightly) greater than men's (OECD 2007).¹

However, my research is not focused on the broad topic of 'women and ICT' but only on a part of it, corresponding with the acronym IT, i.e. information technologies or 'computing technologies'. I will leave aside, then, 'communication technologies' like the Internet, and focus on the computational part of these technologies. The reason of this focus is that, although women's access and use of the Internet has increased substantially in the past few years, this is not the case with computer science education and information technology related professions. Indeed, the main topic of much of the literature is the surprising fact that the number of women entering computer science degrees has decreased in the last decade (see Camp 1997). So it seems that there is no correlation between growth in the number of female Internet users and their presence in ICT studies and careers:

In all five countries, there has been a strong growth in access to and use of main ICT technologies like home computers, the Internet and mobile phones (...). This optimistic picture is countered by statistical information about women as ICT professionals. In all five countries, the percentage of women in higher computer science education is very much lower than that of men, and women seem to remain a minority within the ICT industry. *The rapidly growing interest of young women in using ICT does not (yet?) seem to have had any impact upon the low share of young women studying computer science* (Sørensen 2002, 12–13).²

The second reason implies a more theoretical background, and has to do with the difference between production and use. Although we are much concerned with the so-called 'users studies' (Oudshoorn & Pinch 2003; Silverstone & Hirsh 1992) which critique the traditional focus of STS in the design and production spheres of technology, and stress the influence and agency of users in the final outcome of technological developments, I believe, however, that the division between production and use exists, and is decisive in terms of the structural and symbolic organization of technological work.³ The above mentioned works show examples where

consumers and users have exerted a strong influence on the final outcome of a specific technology (for example provoking the abandonment of an artefact from the market and provoking research in new prototypes). However, when we move away from the user's scope and we look at a more 'fundamental' or basic research in computer science for example, the influence of the user becomes more tenuous. This is why I am interested in the situation of women in academic research and production of computer science, since this is where the work of creation and design of new technologies mainly takes place.

The structure of the paper would be as follows. First I will provide a review of the so-called 'women into IT' approach followed by the most important critiques made to it. Secondly I will make a classification of 'gender and IT' studies from a feminist constructivist point of view. This implies the assumption of the 'co-construction of gender and technology'. As this claim is very general, I will try to establish an analytical framework to proceed with the study of the gender-technology relation from a constructivist point of view. To that aim I use Sandra Harding's multi-level theory of gender and how these levels can be analyzed with relation to information technology, both at a general level and in case studies of particular IT developments. In the last section I propose to broaden the scope from the design of concrete artefacts to the study of the theoretical foundations, paradigms and discipline traditions, that is ontological and epistemological issues. I will illustrate this with an example from Artificial Intelligence.

'Women into IT': The liberal feminist approach

In this section I am going to take note of the so-called 'women into IT' approach. It cannot be said that this approach belongs to any particular community, but is mostly a very common way of approaching the issue. However, we can see it is particularly characteristic of the work done by computer scientists themselves (as we can see in the articles about women and computing in *Communications of the ACM*, *SIGSE Bulletin*, or *Journal of Information Technology*) and also by policy makers (reports from the OECD, UNESCO, etc.).

Within this approach we mainly find two kinds of analysis. First, there are uncountable data and statistical research on the under-representation of women in the field. Paradigmatic examples of this kind of studies are those by Pearl et. al. (1990), Frenkel (1990), Klawe and Leveson (1995), Camp (1997). In general, all these studies show that the percentage of women studying computer science is never more than 20 %.

Second, there are analyses that point to different kinds of barriers that women face and prevent them from entering IT education and professions, such as barriers in early socialization, education, recruitment, training or work environments (see the reviews of Ahuja 2002; Gürer & Camp 2002). From this approach, practical proposals rely on political and educational actions directed to produce structural changes in girls' formal education in IT (like girl-only classes, making teachers aware of the problem or mentorship programs), and in employment policies of companies (preventing discriminatory practices, broadening informal networks or improving family-work balance). There are also some recommendations about the necessity of changing social attitudes, although since this is at a relatively general level, the issue is normally addressed in these studies in a very vague way. The main idea is that (numerical) equality in IT will be achieved via promoting and increasing women's access to IT careers and jobs.

Many authors have criticized the 'women into IT' approach in the past few years (some of them as early as 1993, like Flis Henwood) for assuming the liberal feminist discourse of 'gender equity'. This means that, as women and men are equal in terms of capacities, the differences would come from a disadvantaged position of women in terms of material opportunities and differences in socialization. The solution should be to eliminate these differences by overcoming material and socialization barriers.

One of the main critiques to this approach is that it implies a '*deficit model*' of women and girls (Zorn et. al. 2007). The problem is located in women (they have a 'deficit' in education, training, etc.) so they are expected to learn and change, i.e. 'adapt' to technology (by increasing their knowledge and skills in the field but also changing their attitudes to computers). This is very reminiscent of the traditional inclination of considering men as the norm.

The other two main critiques to the 'women into IT' approach are that both technology and gender are *under-theorized* (see Adam et. al. 2004). IT itself is not questioned but taken for granted as value-neutral, which is the traditional determinist understanding of technology. Adam wonders why women and IT analysis have neglected the insights of constructivist studies of technology (STS) for a decade. The same can be applied to the concept of gender. In the 'women into IT' approach gender means 'women and men', which is implicitly accompanied by a kind of gender essentialism (Henwood 1993).⁴ Again, they do not take into account current feminist literature about gender (Adam 1997).⁵

However, recently the traditional discussion within feminism about the plurality of women seems to have also penetrated into women and IT studies, and some authors have criticized the Western-oriented bias of most of the field. For example, works with data from Malaysia or the Soviet Union show how different cultural environments change the relation between women and computer education and professions (Gharibyan & Gunsaulus 2006; Lagesen 2008)

One last problem with the 'women into IT' approach, this time from a strictly practical point of view, is that despite the volume of interventions launched with this background in different countries, they do not appear to have had the expected results, if we take into account current data about the situation of women in IT education and professions.

A research framework drawn on feminist constructivist studies of technology

The failure of the liberal approach to significantly change the proportion of women in IT led some researchers to approach the problem from a different perspective. Based on the STS thesis of the social construction of technology (Bijker et. al. 1987; MacKenzie & Wajcman 1985) on the one hand, and poststructuralist understanding of gender as a social construction on the other (Butler 1990), these studies try to move from *women* and technology to *gender* and technology. Authors like Berg and Lie (1996), Faulkner (2001), Grint and Gill (1995), Lohan (2000) or Wajcman (2004)

criticized the essentialist view of both gender and technology in the feminist studies of the 1980s. Instead, they proposed the thesis of the '*co-construction*' or '*mutual shaping*' of gender and technology. It is said that the feminist constructivist approach implies a change from talking about 'women and / into IT' to 'gender and IT'.

Starting from the idea that neither gender nor technology are static phenomena but constructed in social relations, the challenge is to explain the nature of the gender-technology relation. Technology is not gender-neutral and always implies gender relations (and thus also gender politics).⁶ Therefore the question is HOW (and how much) is technology gendered, as it could be possible that different artefacts are not gendered in the same way or at the same level. As Faulkner says (2001), technology can be 'gendered' in different manners. This should prevent us from the temptation of simplistic explanations of the gender-technology relation, such as, for example, always identifying women with technological incompetence.

Most of the above mentioned authors use Sandra Harding's multi-level theory of gender to proceed with their analyses (Harding 1986). For Harding, gender is an analytical category or ordering principle in which every society is organized. As an analytical category, Harding identifies three levels of the gender system:

Gender difference is a pivotal way in which humans identify themselves as persons [that is, individual gender or gender identity], organize social relations [gender structure] and symbolize meaningful natural and social events and processes [gender symbolism] (Harding 1986, 18).

The fact that Harding identifies these levels does not mean that they are separated in the production of gender. On the contrary, they intertwine and work together in the production and reproduction of each culturally particular gender system. The power of gender comes precisely from the intersection of the three levels.

The most relevant feature of the gender system for feminist studies is, however, that it is not only an 'innocent' division but a *hierarchical* division. We call this 'gender asymmetry'. As Harding says, 'virtually in all cultures, whatever is thought of as manly is more highly valued than what is thought as womanly' (Harding 1986, 16).

Despite the fact that many of the above mentioned authors quote and use Harding's multi-level theory, I miss a more systematic way of using it to proceed in practice with the analysis of the gender-technology relation. I think that the multi-level theory of the gender system can be of much more use if we proceed systematically to investigate the implication of technology *at every level* of the gender system and how one affects each of the others in their co-construction.

Based on the three levels of the gender system, I thus propose an organization of feminist constructivist studies of gender and IT as follows:

- a) First, we have analyses of gender and IT at a general level. At this level, the relation of IT with gender can be divided into: 'gender structure and IT' (sexual division of labour in IT and other patterns of location), 'gender symbolism and IT' (gendered symbolic associations with IT), and 'gender identity and IT' (implications of information technology in the construction of gender identities). As we have already stated, we should not forget the question of gender asymmetry at any level, that is, the gender relations of power involved in IT.
- b) Second, there are studies of gender and IT at a particular level. This includes case studies about gender implications in the production of concrete technologies. At this level the most useful tool is the concept of 'gender script' (Oudshoorn et. al. 2004; Rommes 2000; van Oost 2003).

Gender structure and information technology

Gender structure in Harding's account is related to the sexual division of labour. With regard to technology then, we can say that gender structure in IT is the way in which technological activities are segregated by gender.⁷ At a first glance, the most obvious segregation is that women are scarce in IT higher education and normally placed in low level jobs in the technology labour market (this is referred to as *vertical* or *hierarchical segregation*), as the data of the previous section show. Because of this, I consider studies in the 'women into IT' approach (particularly quantitative and statistical studies) as part of 'gender structure of IT' analyses.

Another obvious fact regarding structure is that women are found more easily in the use realm than in the productive one. Women are more users than designers of technology (*horizontal segregation*). However, *horizontal* does not imply there are no hierarchies. Despite the emphasis on user participation in the design of technological developments in recent studies (Oudshoorn & Pinch 2003; Silverstone & Hirsh 1992), use is traditionally (and still is) seen as a less-valued activity than design. This distribution of gender, in which those in charge of the design phases of technology are mostly men, has to 'affect' in some way the technological outcomes.⁸

The position in the structure also conditions the power relations in society. As the early work of Cynthia Cockburn pointed out, technology in Western society is very much related to power (Cockburn 1985). For Cockburn, technology is a medium of power. Those who own machinery and the skills to use it exercise 'dominance' over other collectives. Masculine appropriation of machinery and skills is a very important part of their situation of power in the gender system.

Finally, we should highlight that the position of women in the structure of technology affects how they will relate with technology in terms of identity, symbolism, and also material conditions (high valued technological jobs receive high incomes, for example). As we stated above, the three levels do not operate separately but work together in the production of technology and vice versa.

Gender symbolism and information technology

In gender and technology studies from a feminist constructivist perspective it is thought that technology is not only material, but also has an ideological and semiotic dimension. In STS this is addressed by the concept of 'technology as culture', which includes not only artefacts but also the set of meanings attached to technology. Semiotic analyses must thus be part of the research on the gender-technology relation. These studies analyze the symbolic (gendered) meanings of IT in relation to gender.

On the one hand, material objects can acquire gendered meanings by association with gendered activities (Faulkner 2001), i.e. domestic technologies are associated with women, tools to fix the car with men, and so on.

On the other hand, there are cases where the use of language and metaphor also implies gendered meanings, for example the use of 'male' and 'female' parts of plugs, or the metaphorical relation of computers with brain (which is known as 'the brain metaphor') (van Oost 2000).

Some studies on 'computer cultures' analyze the symbolic (gendered) meanings of IT such as the masculine images in 'the hacker culture' (also called 'the nerd image of computing') (Håpnes & Sørensen 1995; Mellström 2002). In these cases, computers are constructed as complex and difficult technologies related to masculine skills such as control, and they become a new means of expressing masculinity.⁹

At a more general level, feminist epistemologists have shown that technology in the Western world (as well as science) has been associated with the rationalist discourse based on dichotomies (Code 1991; Harding 1996; Keller 1985). The cultural image of technology (and science) is related to one side of classical dichotomies, which are mutually exclusive and differently valued (the first parts of these dichotomies are more valued than the second):

Men	Women
Machine focused	People focused
Technical	Social
Hard	Soft
Mind	Body
Objective	Subjective
Rational	Emotional
Abstract reasoning	Practical reasoning (common sense)

However, as I stated above, we should avoid essentializing dichotomies and take concrete paths of gendered technological meanings as being fixed. The way in which technology intertwines with gender symbolism is complex and changing. It is necessary to study cases in context to see which

gender meanings are being constructed and how they change over time, to avoid generalist, oversimplified and gender essentialist affirmations. The work of Maria Lohan on the telephone is a very good example (Lohan 2001). First designed (and so related) to men's use for business, after a process of 'appropriation' by women in rural areas to avoid their isolation, it became related to feminine sociability (sometimes with a negative connotation as 'gossip'). This example shows very well the malleability of the interpretative flexibility of artefacts and the dynamic process of their gendered meanings, which, because of this can be re-shaped leaving an open space for agency. Another example related to IT is the 'brain metaphor' relating computers to the human mind, which was not present in this form from the beginning but was constructed in a concrete period of time and for specific reasons (van Oost 2000)

Another fact we should take into account about the symbolic character of technologies is that frequently symbolic associations do not 'match' with real practices. As Faulkner's ethnographic studies show (Faulkner 2000), symbolisms remain although women interact a lot with technology, and although men also use technologies in so-called 'feminine ways'.¹⁰ This shows the power of the symbolic sphere in humans, sometimes more powerful than the 'factual' (and supposedly 'objective') realm.

Gender identities and information technology

Current theories on gender (such as Butler 1990; Connell 1987) postulate that gender has no intrinsic qualities, is not something that we 'have' but something that we 'do'. However, there is not much reference to technology in these authors. On the side of technology studies, STS scholars have not paid enough attention, in my view, to how the articulation and performance of gender identities can be an important aspect of the development of technical artefacts.

Because of that, some researchers from the feminist constructivist perspective (Faulkner 2000; Lohan 2001; Oudshoorn & Pinch, 2003) have addressed the question whether technology is implicated in the construction of subjective gender identities, contributing to the maintenance (or transformation) of particular gender performances. In Oudshoorn's words,

‘technological development requires the mutual adjustment of technology and gender identities’ (Oudshoorn & Pinch 2003, 210).

Individuals construct their identities, among other things, also in relation to technologies (i.e. appropriating objects or engaging in technical activities). As in the case of symbolisms, the relation between identity and technology can be situated both in the realm of the use of artefacts (some artefacts are related to the feminine and some to the masculine sphere) and in the realm of design (this phase, in general terms, is more related to the masculine identities).

At a first glance, the most recognizable relation between technology and gender identities is that masculinity is generally more related to technological skills and competences, and femininity to technological incompetence.¹¹ But, again, we should be able to take account of the plurality of gender identities. As Connell (1987) says, there is not only one type of masculinity or femininity but a multiplicity of gender identities: masculinities and femininities are plural and can change. Because of that, symbolic associations between particular technological performances are related to different kinds of masculine identities.¹²

One paradigmatic case of a gender identity related to technology is that of the engineer (see Faulkner 2000; Mellström 2002). There are historically strong and enduring alignments of the field of engineering with masculinity. But, as these authors show, engineering related to *one type* of masculinity. For example, one kind of masculinity (working-class masculinity) is related to heavy and greasy machinery while others (like for example engineers) are related to clean and light technologies like ICTs. These examples show in different ways the complex and sometimes contradictory relation of gender identities and technology.¹³ By designing and using particular technologies, men and women perform different gender identities that reflect, but can also challenge, gender stereotypes in relation to technology.

Gender and IT at a particular level: The ‘gender-scripts’ approach

Another line of research within feminist constructivist studies of technology has been devoted to analyzing the interrelation of gender in the development of concrete technologies. In this context authors like Ellen

van Oost and Els Rommes have developed the concept of ‘gender script’ as a tool for this analysis (Oudshoorn et. al. 2004; Rommes 2002; van Oost 2003).

Based on Akrich’s concept of ‘script’ which states that designers’ assumptions about users have not only a symbolic dimension but are *materialized* in the resultant technology (Akrich 1992), the term ‘gender script’ is explained by van Oost as follows: “‘Gender script’ refers to the representations of gender relations and gender identities designers have, which then inscribe into the materiality of an artefact’ (van Oost 2003, 195).

Therefore, gender is not only ‘associated’ to artefacts, nor they acquire gendered connotations only when they arrive to the realm of their use (as determinist conceptions of technology would admit), but designers incorporate gender *into the very materiality* of artefacts. Because of the material characteristics of the scripts, they strongly condition the future uses of that technology and ‘guide’ to a certain extent the gender meanings (symbolism) of artefacts, and also gender-related performances.

Rommes analyzes how gender scripts affect gender on the three levels of the gender system that we already mentioned: they can reinforce gender differences in the division of labour by delegating different competencies to men and women (gender structure), they can normalize stereotypical male and female behaviour (gender identities), which implies the reinforcement of the gendered meanings associated with that technology (gender symbolism) (Rommes 2002, 18). As the gender system is asymmetrical in terms of power, gender scripts normally tend to maintain and reinforce prevailing gender inequalities.

But, as we have already stated, from a constructivist perspective we should always try to avoid essentialism. Scripts can be ‘followed’ and, in van Oost’s words ‘scripts surely act invitingly and/or inhibitingly’ (van Oost 2003, 196). The power of scripts can not be ignored and many examples show that what a script prescribes strongly affects users’ gender performances. However, scripts are never fixed forever, and they can be changed, adapted or rejected. Gender scripts may emphasize and reinforce gender differences and inequalities, but can also be used to diminish them.

Shortcomings of feminist constructivist studies: Broadening the frame to epistemology

Despite the fact that feminist constructivism, as I have explained above, appears to me to be the best framework for a systematic analysis of the gender-technology relation, it is not exempt from critique. Far from invalidating the framework, however, I regard these points of critique as shortcomings that, if taken into account, can provide the best way to improve the research framework.

The first critique is related to the old feminist 'phantom' of gender essentialism. Despite the fact that most of the authors I have included as feminist constructivist explicitly assume the thesis of the co-construction of gender and technology, some recent works such Landström (2007) or Stepulevage (2001) have noted that there exists a (maybe unintended but still quite visible) tendency to gender essentialism.

In works and case studies of Wajcman, Faulkner, Oudshoorn or Rommes (op. cit.) they usually talk about women and men, or, in some cases, about 'feminine-related values', 'feminine skills' or 'feminine styles' (of communication, of programming, etc). At the end, this will reinforce the gender binary and mainstream gender stereotypes (Landström 2007). It is necessary, instead, to analyze the contradictions, variability of symbols and plurality of gender identities in their relation to IT.

Pluralities in relation to IT will come from different cultural and social backgrounds (as we have said about the situation of Malaysia or the former Soviet Union), but also with relation to sexuality. This second source of gender identity pluralism has been even less treated in gender and IT studies, and I think the works of Landström and Stepulevage represent a very promising line of work for future investigation. Their main idea is that there needs to be an analysis that considers the inter-relationship between computing, gender and heterosexuality.

If the first critique regards 'gender', the other critique has to do with the other part of the tandem: technology, which in this case refers to IT (or computer science). 'Computing' has not been much questioned and, as a result not very well theorised. Computer science and IT themselves need to be questioned and de-constructed to avoid technological determinism.

Björkman & Trojer (2006) say that it is needed an analysis of what they call 'the discipline itself', which means not only studying concrete applications such as particular software programs (as in gender-scripts studies), but asking about the foundations, mainly epistemological, of computer science as a discipline. These foundational features come from a long tradition and affect the way computing hardware and software is made (far preceding concrete software applications). As Bath (2008) says gender affects the activities of computer scientists and the development of their products, methods, theories and foundations (i.e. modelling methods and information representation and classification), and it is necessary to analyze the processes of how computational artefacts become gendered on the structural, symbolic, but also on the ontological and epistemic levels.

The idea is thus to focus on the foundations of computer science, by examining the fundamental concepts of the discipline. Björkman and Trojer (2006) identify two ways of analyzing 'Computer Science itself':

- a) Studying how paradigms (theories and methods) in the discipline are constructed and maintained. This involves looking at the paradigmatic basis of computer science (for example, studying why certain dogmas of science such as 'pure mathematics' are so relevant to the discipline) and whether other paradigms can be seen as alternative ways.¹⁴ Some feminist researchers, who are also computer scientists themselves, have addressed the issue of paradigms in computer science, like Heidi Schelhowe (2004).
- b) Focusing on epistemological questions. This means asking how knowledge is constructed within the history of the discipline, which ways of knowing are considered 'valid' (i.e. logic, linear and abstract thinking), who 'has' or has appropriated that kind of knowledge, etc. In this context, it is Alison Adam (1998) who has made the most important contribution to understanding how gendered concepts have shaped the content of computer science in her analysis of the history of Artificial Intelligence.

This second perspective is based on the insights of feminist epistemologies. Feminist epistemology (Code 1991; Keller 1985; Harding 1986) pointed out that knowledge processes are configured by gender ideologies and

gender metaphors. Each 'type' of knowledge is related in our culture to a particular way of understanding gender. This symbolic association affects knowledge itself, which at the same time naturalizes the existing metaphors, and relegates other types of knowledge to a secondary role. In this way, the tools that feminist epistemologies developed for the study of western science can be applied to the study of computer science, addressing the particular characteristics of this field.¹⁵

To proceed with a study of the epistemological issues in computer sciences I regard the field of Artificial Intelligence (AI) as being of much interest. It is commonly said among AI practitioners that what was once considered part of AI later became part of other branches of computer science.¹⁶ AI is an experimental field in the sense that it is not usually aimed at designing products for the market (such as software engineering or computing architectures – hardware) but at trying new methods and ways of creating 'intelligent machines'.

Alison Adam's work is devoted, precisely, to making explicit the implicit assumptions or 'inscriptions' in the way 'intelligence' and 'knowledge' are conceived in Symbolic AI (the tradition that emphasizes representation in symbolic form, which was the main paradigm in AI from the 1950s to the 1980s). One of Adam's theses is that traditional AI systems are based on the Cartesian ideal of a disembodied mind and the over-valuation of mental (abstract) knowledge over corporeal (concrete) knowledge; the former being historically associated with the masculine realm while the latter with the feminine. Adam shows that traditional AI is based on the rationalistic epistemological model of 'S knows that p', and is, of course, 'gender blinded'.

Regarding the knowledge subject 'S', it corresponds with the ideal knower of modern science, which is an anonymous, universal, disinterested subject that 'knows from nowhere'. Against this view, feminist epistemology emphasizes the 'situatedness' of the knower. Regarding the object of knowledge (or 'p'), in Symbolic AI corresponds with the kind of knowledge that can be represented in a declarative or propositional form (*knowing that*). Other types of knowledge, such as skills-type (*knowing how*) or common-sense knowledge are considered less important, which involves an *epistemic discrimination* not innocent of gender factors.

Future work in this direction should investigate new approaches in Artificial Intelligence, whose features are very different from early approaches such as Symbolic AI, from a feminist epistemological point of view. As some authors have started to do with other new approaches in AI such as social and emotional robotics (Weber & Bath 2005), it would be interesting to apply feminist epistemology's insights to a new field within AI known as Soft Computing. Coined by Lotfi Zadeh in the early 1990s (Zadeh 1994), Soft Computing differs from conventional (hard) computing in the use of new methodologies (such as fuzzy logic, neural networks and genetic algorithms) to cope with imprecision, uncertainty, partial truth, and approximation. As Zadeh says, this represents a significant paradigm shift in the aims and ways of doing computing. It would be very interesting to apply a feminist constructivist gender analysis, including ontological and epistemological issues, to investigate whether these new approaches and paradigms in AI would involve a difference in the future constructions of gender and information technologies.

Notes

- ¹ However in 2006 male access was at least 5 percentage points greater than that of women in more than half of the 23 OECD countries. And it must also be said that, in all the countries, the gaps remain large in older age groups, and in areas of newer technologies.
- ² My emphasis.
- ³ The type of agency that an engineer in an R & D laboratory can perform is not the same as, for example, a woman from a rural area in a developing country using the Internet, or even a group of users in a developed country organized to reject certain proprietary software.
- ⁴ The same critique can be applied to cyberfeminism. The most famous cyberfeminist authors (such as Sadie Plant 1998 or Sherry Turkle 1984) at least, can be interpreted as maintaining a 'gender-difference' perspective, which implies that women and men have different characteristics that lead them to use (and create) technology in a different way. The feminine way of being (flexible, communicative, interactive ...) is positively related to new digital technologies, which are thought of as intrinsically liberating. The techno-optimist tone of this literature contrasts with the more critical and elaborated debates of feminist

constructivism, which can be well related to Donna Haraway's *cyborg-feminism* (1991), but not to what it is commonly known as cyberfeminism.

- 5 However I think that Adam, in her own research (i.e. Adam 1998), does not use a very constructivist (poststructuralist) approach to gender but rather the feminist standpoint approach.
- 6 We can call this approach feminist constructivist studies of technology, but others term it 'feminist technoscience studies' to emphasize the heterogeneous character – humans and non-humans – of the co-constructed networks.
- 7 Cockburn and Ormrod (1993) do not use the term 'gender division of labor' but 'gendered patterns of location', to highlight that there are more technology-related activities than those considered 'labour', for example educational settings, domestic environments and leisure activities.
- 8 However, we must be careful to avoid both social determinism and gender essentialism when analyzing the way gender intervenes in technology construction. From a feminist constructivist perspective the idea is not that gender 'affects' technology but that technology and gender are constructed together during the process.
- 9 In earlier times, however, computers were associated with routine office work performed principally by women, which made them related to femininity (though, in this case, computers did not have such a high status) (Henwood op. cit).
- 10 Lohan shows how men also use the telephone to call friends and cultivate social relations, but the symbolic charge of these activities is still identified mostly with women.
- 11 Skills are important for the auto-conception of the self because people identify themselves very much with what they do (i.e. professional identity).
- 12 The turn from 'women' to 'gender' in feminist studies of technology opened a new alliance with areas that developed separately from women's studies such as the field of men's studies. Authors like Faulkner, Lohan, Lie or Mellström try to include the insights of men's studies into the analyses of the gender-technology relation.
- 13 However, Connell's concept of 'hegemonic masculinity' points out that not every identity holds the same position in society in terms of power (between genders and among genders) (Connell 1987, 185–186). Connell identifies heterosexuality as the most important aspect of contemporary hegemonic masculinity.
- 14 This is also the proposal of Philip Agre with his concept of 'critical technical practice' whose steps are: 1) identifying core metaphors of the field, 2) noticing what is marginalized when working with these metaphors, 3) inverting dominant metaphors, bringing that margin to the center, and 4) embodying the alternative into the new technology (Agre 1997).

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- 15 Computer science is not only a representational discipline but very related to engineering, which implies practical intervention and material transformation of the world.
- 16 The same field of what is today considered computer science was known as 'artificial intelligence' in the 1950s.

References

- Adam, Alison (1998), *Artificial Knowing: Gender and the Thinking Machine*, London / New York: Routledge.
- Adam, Alison, Howcroft, Debra, and Richardson, Helen (2004), 'A decade of neglect: Reflecting on gender and IS', *New Technology, Work and Employment* 19 (3): 222–240.
- Agre, Philip (1997), *Computation and Human Experience*, Cambridge: Cambridge University Press.
- Ahuja, Manju (2002): 'Women in the information technology profession: A literature review, synthesis and research agenda', *European Journal of Information Systems* 11: 20–34.
- Akrich, Madeleine (1992), 'The de-scription of technical objects', in Wiebe Bijker and John Law (Eds.), *Shaping Technology / Building Society*, Cambridge: MIT Press, 205–224.
- Bath, Corinna (2008), 'De-gendering computational artefacts: From gender analysis to technology design methodologies', *Yearbook 2008 of the Institute for Advanced Studies on Science, Technology and Society*, Munich / Vienna: Profil.
- Berg, Anne Jorunn and Lie, M. (1996) 'Feminism and constructivism: Do artifacts have gender?', *Science, Technology & Human Values* 20 (3): 332–351.
- Bijker, Wiebe, Hughes, Thomas, and Pinch, Trevor (Eds.) (1987), *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, Cambridge, MA: MIT Press.
- Björkman, Christina and Trojer, Lena (2006), 'What does it mean to know computer science? Perspectives from gender research', *TripleC* 4 (2): 316–327. Available at <http://tripleC.uti.at> [Downloaded 8 May 2008].
- Butler, Judith (1990), *Gender Trouble. Feminism and the Subversion of Identity*, New York: Routledge.
- Camp, Tracy (1997), 'The incredible shrinking pipeline', *Communications of the ACM* 40 (10): 103–110.

- Castells, Manuel (2001), *The Internet Galaxy. Reflections on the Internet, Business, and Society*, Oxford, UK: Oxford University Press.
- Code, Lorraine, (1991), *What Can She Know? Feminist Theory and the Construction of Knowledge*, Ithaca: Cornell University Press.
- Cockburn, Cynthia (1985), *Machinery Dominance. Women, Men and Technical Know-How*, London: Pluto Press.
- Cockburn, Cynthia and Ormrod, Susan (1993), *Gender and Technology in the Making*, London: Sage.
- Connell, Robert W. (1987), *Gender and Power: Society, the Person and Sexual Politics*, Cambridge, UK: Polity Press.
- Faulkner, Wendy (2000); 'The power and the pleasure? A research agenda for "making gender stick" to engineers', *Science, Technology, & Human Values* 25 (1): 87–119.
- Faulkner, Wendy (2001), 'The technology question in feminism: A view from feminist technology studies', *Women's Studies International Forum* 24 (1): 79–95.
- Frenkel, Karen A. (1990), 'Women & computing', *Communications of the ACM* 33 (11): 34–46.
- Gharibyan, Hasmik and Gunsaulus, Stephan (2006), 'Gender gap in computer science does not exist in one former Soviet Republic: Results of a study', *Proceedings of the 11th annual SIGCSE conference on Innovation and technology in computer science education (ITiCSE'06)*: 222–226.
- Grint, Keith and Gill, Roslyn (Eds.) (1995), *The Gender-Technology Relation: Con-Temporary Theory and Research*, London: Taylor & Francis.
- Gürer, D. and Camp, T. (2002), Investigating the Incredible Shrinking Pipeline for Women in Computer Science, Report for the National Science Foundation Project 9812016. <http://women.acm.org/documents/finalreport.pdf> [Downloaded 6 December 2007].
- Håpnes, Tove and Sørensen, Knut H. (1995), 'Competition and collaboration in male shaping of computing: A study of a Norwegian hacker culture', in Keith Grint and Roslyn Gill (Eds.), *The Gender-Technology Relation: Contemporary Theory and Research*, London: Taylor & Francis, 174–191.
- Haraway, Donna (1991), *Simians, Cyborgs, and Women: The Reinvention of Nature*, New York: Routledge.
- Harding, Sandra (1986), *The Science Question in Feminism*, Ithaca: Cornell University Press.
- Henwood, F. (1993), 'Establishing gender perspectives in information technology: Problems, issues and opportunities', in E. Green, J. Owen, and D. Pain (Eds.),

60 Verónica Sanz

Gendered by Design? Information Technology and Office Systems, London / Washington: Taylor & Francis: 31–49.

Klawe, Maria and Leveson, Nancy (1995), 'Women in computing. Where are we now?', *Communications of the ACM* 38 (1): 29–35.

Keller, Evelyn Fox (1985), *Reflections on Gender and Science*, New Haven: Yale University Press.

Landström, Catharina (2007), 'Queering feminist technology studies', *Feminist Theory* 8 (1): 7–26.

Lagesen, V. A. (2008), 'A cyber feminist utopia? Perceptions of gender and computer science among Malaysian women computer science students', *Science, Technology and Human Values* 33 (1): 5–27.

Lohan, Maria. (2000), 'Constructive tensions in feminist technology studies', *Social Studies of Science* 30 (6): 895–916.

Lohan, Maria (2001), 'Men, masculinities and "mundane" technologies: The domestic telephone', in Eileen Green and Alison Adam (Eds.), *Virtual Gender: Technology, Consumption and Identity Matters*, New York: Routledge: 189–206.

MacKenzie, Donald and Wajcman, Judy (Eds.) (1985), *The Social Shaping of Technology*, Milton Keynes: Open University Press.

Mellström, Ulf (2002), 'Patriarchal machines and masculine embodiment', *Science, Technology and Human Values* 27 (4): 460–467.

OECD (2007), ICTs and Gender. Working Party on the Information Economy, DSTI / ICCP / IE(2006)9 / FINAL, <http://www.oecd.org/dataoecd/16/33/38332121.pdf> [Downloaded 16 December 2009].

Oudshoorn, Nelly and Pinch, Trevor (Eds.) (2003), *How User Matter. The Co-Construction of Users and Technology*, Cambridge / London: MIT Press.

Oudshoorn, Nelly, Rommes, Els and Stienstra, Marcelle (2004), 'Configuring the user as everybody', *Science, Technology & Human Values* 29 (1): 30–63.

Pearl, Amy et al. (1990), 'Becoming a computer scientist: A report by the ACM committee on the status of women in computing science', *Communications of the ACM* 33 (11, November): 47–58.

Plant, Sadie (1998), *Zeros + Ones: Digital Women and the New Technoculture*, London: Fourth Estate.

Rommes, Els (2002), *Gender Scripts and the Internet. The Design and Use of Amsterdam's Digital City*, Enschede: Twente University.

- Schelhowe, Heidi (2004), 'Paradigms of computing science. The necessity for methodological diversity', *Gender, Technology and Development* (3, Sept.–Dec.): 321–334.
- Silverstone, Roger and Hirsch, Eric (Eds.) (1992), *Consuming Technologies: Media and Information in Domestic Spaces*, London / New York: Routledge.
- Sørensen, Knut H. (2002), *Love, Duty and the S-Curve. An Overview of Some Current Literature on Gender and ICT*, IST-2000-26329 SIGIS Deliverable Number: D02_Part 1 http://www.rcss.ed.ac.uk/sigis/public/displaydoc/full/D02_Part1 [Downloaded 15 October 2008].
- Stepulevage, Linda (2001), 'Gender / technology relations: Complicating the gender binary', *Gender and Education* 13 (3): 325–338.
- Turkle, Sherry (1984), *The Second Self: Computers and the Human Spirit*, New York: Simon & Schuster (second revised edition: MIT Press, 2005).
- Van Oost, Ellen (2000), 'Making the computer masculine: The historical roots of gendered representations', in E. Balka and R. Smith (Eds.), *Women, Work and Computerization: Charting a Course to the Future*, Boston, MA / Dordrecht / London: Kluwer, 9–16.
- Van Oost, Ellen (2003), 'Materialized gender: How shavers configure the users' femininity and masculinity', in Nelly Oudshoorn and Trevor Pinch (Eds.) (2003), *How User Matter. The Co-Construction of Users and Technology*, Cambridge / London: MIT Press, 193–208.
- Wajcman, Judy (2004), *Technofeminism*, Cambridge, UK: Polity Press.
- Weber, Jutta and Bath, Corinna (2005), "'Social" robots & "emotional" software agents: Gendering processes and de-gendering strategies for "technologies in the making"', in Jacqueline Archibald, Judy Emms, Francis Grundy, Janet Payne, and Eva Turner (Eds.), *The Gender Politics of ICT. Proceedings of 6th International Women into Computing Conference 2005*, 121–131.
- Zadeh, Lotfi (1994), 'Soft computing and fuzzy logic', *IEEE Software* 11 (6): 48–56.
- Zorn, Isabel, Maas, Susanne, Rommes, Els, Schirmer, Carola, and Schelhowe, Heidi (Eds.) (2007), *Gender Designs IT. Construction and De-Construction of Information Technology*, Wiesbaden: VS Verlag für Sozialwissenschaften.