Free/Libre and Open Source Software: Policy Support

FLOSSPOLS

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Gender: Integrated Report of Findings

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1. Executive Summary

1.1 Aims of the Study

We proposed to study the role of gender in free/libre/open source software (F/LOSS) communities because an earlier EC study (Ghosh et al 2002, 2005) revealed a significant discrepancy in the proportion of men to women. It showed that just about 1.5% of F/LOSS community members were female at that time, compared with 28% in proprietary software (NSF 2004). We set out to find reasons behind this bias and make recommendations for actions that might improve the ratio of women to men. As F/LOSS constitutes an increasingly significant arena of technological advancement and economic development, it has become an important public policy question. Through an ethnographic study consisting of empirical surveys, participant observation and qualitative interviews, we aimed to provide the world's first comprehensive study of gender in F/LOSS and develop policies to maintain the EU's leading role in this field.

On the surface, it appears that few people within the community feel this gender disproportion is desirable: our survey showed that 66% of men and 85% of women agreed that more female participants would be better for the whole F/LOSS community. This led us to pay particular attention to the social dynamics within F/LOSS that keep it so thoroughly male dominated, at the same time as the majority of participants express a preference for a more balanced community.

1.2 Key Findings

Listed below are the factors significant in excluding women from F/LOSS communities. These factors are nearly all underwritten by a central cultural dynamic within F/LOSS. F/LOSS participants, as in most scientific cultures, view technology as an autonomous field, separate from people. This means that anything they interpret as 'social' is easily dismissed as 'artificial' social conditioning. Because this 'conditioning' is considered more or less arbitrary, in their view it is supposed to be

easily cast aside by individuals choosing to ignore it. F/LOSS also has a deeply voluntarist ethos which values notions of individual autonomy and volition. As a result *participants largely do not believe that gender has anything to do with their own individual actions.* The situation is thereby perpetuated in spite of the expressed desire for change.

1.2.1 Women are actively (if unconsciously) excluded rather than passively disinterested. The effect lies within F/LOSS cultural and social arrangements. The exclusion happens among people who often do not mean to appear, and who do not interpret their own actions, as hostile to women. The effect is an outcome of the importance given to the individual as the sole carrier of agency.

1.2.2 F/LOSS communities actively perpetuate a 'hacker' ethic, which situates itself outside the 'mainstream' sociality, but equates women with that mainstream. Women are treated as either alien Other or (in online contexts) are assumed to be male and thus made invisible. Women are seen as innately more able to organise, communicate and negotiate among F/LOSS projects as well as with the outside world. Thereby they become carriers of sociality that is seen in a contrast to the 'technical' realm ascribed to men. Additionally F/LOSS women receive a high level of attention due to their gender which decreases their feeling of acceptance as community members as well as their willingness to further engage with the community.

1.2.3 F/LOSS rewards the producing code rather than the producing software. It thereby puts most emphasis on a particular skill set. Other activities such as interface design or documentation are understood as less 'technical' and therefore less prestigious. This has consequences both for the lower valuation of activities in which F/LOSS women often engage as well as for the software itself which often is still oriented more towards the developer rather than the user.

1.2.4 F/LOSS production and infrastructure is designed and built assuming contributors have a long history with computers, but women tend to engage later in their lives with computers. In order to join women have a larger amount of

catching up work to do, which they must do in an environment that almost exclusively values independent discovery.

1.2.5 Inflammatory talk and aggressive posturing ('flaming') is accepted within many F/LOSS projects as a key means of developing reputation. Whereas more established F/LOSS members engage less in 'flame wars', people still establishing their reputation often use them as a platform to make themselves visible. This is often off-putting for newcomers and less experienced contributors who are not yet familiar with the community, its norms, or its real hierarchy. The effect is particularly pronounced in the case of women, who in most cases have a shorter history in computing and therefore less confidence in defending themselves on technical grounds. 'Flaming' thus exacerbates the confidence difficulties women tend to have as a result of lower levels of previous computing experiences.

1.2.6 *The reliance on long hours of intensive computing in writing successful code means that men, who in general assume that time outside of waged labour is 'theirs', are freer to participate than women, who normally still assume a disproportionate amount of domestic responsibilities. Female F/LOSS participants, however, seem to be able to allocate a disproportionate larger share of their leisure time for their F/LOSS activities. This gives an indication that women who are not able to spend as much time on voluntary activities have difficulties to integrate into the community.*

1.3 Key Recommendations

Because of the central dynamic of individualism and dismissal of 'the social', we recommend that public policy action should emphasise the technological gains that could be made if F/LOSS had a larger and more diverse developer base. Based on this approach, we recommend the following (which are elaborated and given as detailed suggestions in the main body of the report (see Section 6):*Provide tangible resources to help women devote time to their F/LOSS activities. This means both funding helping women to take part at specific F/LOSS events, as well as continuous support to enable women to take part in F/LOSS projects over a longer period of time.*

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1.3.2 Foster the participation of girls in F/LOSS activities at an early age.

1.3.3 Provide support for the efforts to increase female participation that are already taking place within F/LOSS.

1.3.4 The European Commission, and EU Governments should use their commissioning role to encourage a greater variety of working methods in the production of software.

1.3.5 Modify the criteria for the selection of software products supported by the European Commission to ensure encouragement is given to those who positively include women in technical roles or offer other means of support for encouraging girls and women to enter computing.

1.3.6 Sponsor exchange programs or joint projects with parts of the world where coding is not axiomatically gendered as a 'male' activity.

1.3.7 Create a greater understanding, through research and dissemination of projects where technological success was achieved because of diversity.

1.3.8 Encourage individuals in leadership positions to recognise that people are being actively put off, not just failing to choose to participate, and that this has a long term cost to F/LOSS development.

1.3.9 Foster a greater role for F/LOSS in European innovation policy, and specifically in university technology transfer activities.

2. Introduction to F/LOSS

Free / libre / open source software (F/LOSS) groups and projects are self-declared 'communities' which see themselves as providing a better alternative to the way in which software is traditionally produced and distributed. A central component of the F/LOSS ethos is that working openly and sharing the source code of software enables improvements to evolve more effectively, and that as a whole 'better' software is produced. The 'free' in free software is envisioned as part of a broader ethos of freedom of speech and volition rather than a reference to price. The key notion is "Free as in free speech not as in free beer." French language here makes the distinction more accurately—*libre* rather than *gratis*. Promoters of '*logiciel libre*' (free software) refer to ethics as necessary for participation. Indeed, the term 'open source' tends to be used in more commercial contexts and free or *libre* in public advocacy modes. While some developers are less interested in these distinctions, they do share a rather consuming enthusiasm for the idea that coding is its own moral reward.

F/LOSS is usually associated with its take on intellectual property rights, but it is also a system of production that has been variously likened to a gift economy (Raymond 1998), a guild system (Coleman 2001) a barter economy (Ghosh 1998) and kinship system (Zeitlyn 2003). It can be described as a flexible network of individuals who work in a state of co-ordinated independence. Stephen Weber describes it as:

> "an emerging technological community that seemed to solve what I see as very tricky but basically familiar governance problems in a very unfamiliar and intriguing way. In the end I've decided (…) that the open source community has done something even more important. By experimenting with fundamental notions of what constituted property, this community has reframed and recast some of the most basic problems of governance" (Weber 2004:vii).

F/LOSS development involves a hybrid mix of institutions. Some firms make the development of open source software their business (e.g. MySQL AB), while others such as IBM opt for implementing and servicing F/LOSS products. Development projects within universities and research institutes such as the Institut Pasteur also

make software available under a F/LOSS licence. Traditionally, however, it has been individuals who contribute outside of their capacities as private or public sector employees or students.

Although total numbers of participants are hard to come by, projects can range from one or two people to several thousands (e.g. in the case of Debian). As Krishnamurthy (2002) and Comino et al (2005) observe, only about 4% of projects have more than seven people working on them. However, at this point it is impossible to tell whether the majority of contributors are in fact concentrated in larger projects. It is probable that this is the case, as projects with larger numbers of developers are more likely to be downloaded (Krishnamurthy 2002), and usage is the most common entry point for becoming a contributor.

Contributors are normally at some geographic distance from one another. Communication takes place largely online via Internet Relay Chat (IRC), mailing lists, blogs (often connected to large projects via RSS feeds) or websites (e.g. wikis).

On the other hand there is also significant face to face activity within local Linux User Groups (LUGs), advocacy groups or people interested in a certain programming language. Furthermore there are large and small conferences across the globe where participants get together to further their projects.

3. Method of Study

3.1 Ethnographic and Quantitative Methods

This report primarily relies on anthropological research carried out amongst F/LOSS participants in France and other parts of Europe in 2004 and 2005. For readers unfamiliar with ethnographic work we highlight here some of the salient points of ethnography as the epistemological vehicle through which we have made our evaluations. Although ethnography has been appropriated into other disciplines as shorthand for detailed observational work, in the original sense used here ethnography additionally implies both an interpretive epistemology and reflexivity. In this case Krieger conducted unstructured and semi-structured interviews, but also met participants in private homes, pubs, bars and restaurants, observed and participated in F/LOSS projects both electronically and face to face, was in touch with companies which used open source software in their business and attended conferences as well as free software advocacy events. These activities variously used French, German and English. Krieger also learned the basics of the technical terminology and languages so that he could better understand the communication within the community. We have closely followed Association of Social Anthropologists of the UK and Commonwealth's ethical guidelines (1999) in this work. In addition, one of our key informants, Hanna Wallach, has actively participated in the analysis process.

We also employed quantitative research methodology. We conducted a quantitative survey on gender among F/LOSS contributors. The survey was carried out online and encompassed 1541 participants

3.2 The Advantages to Selected Methods

The close personal involvement of ethnographic research enables the researcher to

experience others' points of view, and forces him or her to challenge assumptions embedded in both previous research and their own cultural expectations. Unlike the survey data, where claims to generality can be made via mathematical operations, generalising from ethnographic work is done via interpretation as in the humanities. The strength of ethnography is in identifying assumed positions and concepts, but it is important to emphasise that this does not mean that its significance is limited to the cases it studies. Instead, interpreting what the researcher observes and experiences involves drawing out the connections between the field site and the models produced by other researchers in other locations (see Strathern 1999).

The ethnographic approach has helped us identify issues with EU-wide implications. We have interpreted our observations in the light of similar studies on gender and technology undertaken in other parts of the world and make reference to this corroborating evidence where appropriate.

This interpolation has been especially important because F/LOSS is essentially a trans-national community. Although a lot of the offline parts of the fieldwork have been undertaken in France, parts of it were also conducted in other European countries (England, Wales, Germany and the Netherlands) as well as other countries (North America and India). The theoretical frameworks that we have interpreted our findings through come from research based all over Europe and North America. Indeed, all the research sites are suffused with all sorts of transnational connections. There is a tendency in EU research discourse to conceive of social borders as national borders. In the case of F/LOSS this is misguided, as it is a community that largely conceives of itself in global terms. Transnational / networked identities are vital; this report takes as given that the social world in which our informants act is suffused with this complexity. In addition, people move rapidly between projects and institutional arrangements, which makes forms of institutional 'locality' inappropriate units of analysis when it comes to questions that permeate the whole community, such as gender. Therefore our analysis takes place at the level of a F/LOSS 'community' discourse and practice.

Women in F/LOSS are rare. At the beginning of the research most interaction with

women in the community took place online, either on IRC or via email.

Mixing quantitative and qualitative methods has proved to be a robust way of approaching social science problems, as each raises issues the other necessarily overlooks (Anderson and Tracey 2002). As with Anderson and Tracey's work, we mixed methods iteratively. The research topic was identified through previous quantitative work (Ghosh et al 2002). The early stages of ethnographic fieldwork suggested potential topics for further quantitative investigation, the results of which prompted us to re-interpret certain qualitative findings. Because surveys are limited in the kinds of phenomena they can address, the quantitative work acts as a supplement in this project rather than as a 'validator'.

Much of the literature on gender and technology argues for getting past dualities of masculinity and femininity (see section 5). For this study, getting past dualities also meant looking beyond that which is understood as gender, and to examine more broadly the social and cultural aspects of F/LOSS. The conditions of gendering are the same for people before they choose to enter F/LOSS, and these are well understood (see Sorensen 2002, Ahuja 2002, Dryburgh 2000, Spilker & Sorensen 2000 for reviews). Whatever it is that produces the strong male dominance within F/LOSS is likely to be related to its community dynamics. For this reason we have also drawn on the anthropology of personhood and morality. Most studies about gender and technology do not explore these other issues; here we argue that while femininity, masculinity and technology are in fact co-produced, it is also vital to understand the terms on which these productions are made salient. We have found that concepts of personhood and personal agency make gender important in culturally-specific ways (see section 4.1).

Similarly, we found that most of the gender and technology scholarship tends to not address or take seriously indigenous explanations of gender difference, as if the people under study did not have their own understandings of how social relations work. Indeed in one study Wilson (2003) bemoaned how female computer science students were delusionally complicit in their own disadvantage without exploring what is at stake in the supposed 'complicity'. We feel this is related to the relative

inattention given to notions of personal agency, which in the instance of F/LOSS at least both shapes gender differences and limits the kinds of public policy solutions available.

3.3 Limits of the Methods

F/LOSS women proved challenging to identify, as they are few in number but also because some of them assume gender-neutral or masculine online identities. This hindered somewhat both qualitative and quantitative work. It was even more difficult to identify participants who had left F/LOSS.

We were also limited by the range of projects we studied qualitatively. This was not a project study per se, such as the numerous studies of F/LOSS projects (e.g. Hemetsberger and Reinhardt, 2004, Garzarelli and Galoppini 2003, Ratto 2003). The justification for this is as follows. We worked with individuals involved in a range of projects, some smaller, some larger. Current research shows that people engage in several projects at any one time. Contributors have different roles depending on which project they are contributing to. Furthermore projects are not necessarily independent from each other in terms of code either. Code is reused in different projects. Furthermore projects often necessarily collaborate with other projects so that boundaries are not always clear (e.g. see the Free Desktop projects in which contributors to all major Linux desktops are taking part). Most of our key informants work either in several projects in parallel or did so in past.

One of our key informants who became an unofficial research assistant is a Debian Women activist. Although we have enough familiarity with a wide range of activities to know what is particular to Debian and what exists across F/LOSS, nevertheless this background is bound to have had an influence.

Another limitation was that there was no psychological expertise on the team. In the analysis period we came to understand that for many in the F/LOSS community, gender disparity could be explained by the recognition that F/LOSS may contain a

disproportion of people on the autistic spectrum. It is currently also commonly understood that there is a disproportionate number of males to females who are on this spectrum. The active disassociation with the 'social' we understand as a socially constructed way of performing a particular kind of masculine and individualist identity. However, it is entirely possible that for a minority this dissociation goes beyond issues of social identity given that autism has been correlated with males in mathematical and engineering fields in higher education (Baron-Cohen et al 1997).[1] Although we accept that, from a medical anthropology point of view, such psychological diagnoses themselves sometimes constitute cultural practices of pathologising that which is considered socially unacceptable, we have no evidence that could dismiss an autism link out of hand. Addressing the potential ramifications of this is beyond our expertise. However, the consistency that characterizes a hostile environment for women in F/LOSS suggests a cultural configuration that extends well beyond possible links with something called autism. Therefore we do not feel this limitation constitutes an outright hindrance to this study.

[1] While some scholarship on autism points to an explanation similar to the ideas of F/LOSS participants we heard, there is disagreement among experts as to the influence of social factors on the phenomenon.

4. Discussion of Findings

4.1 Women are actively (if unconsciously) excluded rather than passively disinterested. The effect lies within F/LOSS cultural and social arrangements. The exclusion happens among people who often do not mean to appear, and who do not interpret their own actions, as hostile to women. The effect is an outcome of the importance given to the individual as the sole carrier of agency.

One of the documents newcomers to F/LOSS encounter is a Portrait of J. Random Hacker, written by one of the most vocal F/LOSS members, Eric Raymond. A section addresses gender:

> "Hackerdom is still predominantly male. However, the percentage of women is clearly higher than the low-single-digit range typical for technical professions, and female hackers are generally respected and dealt with as equals….
> …When asked, hackers often ascribe their culture's gender- and color-blindness to a positive effect of text-only network channels, and this is doubtless a powerful influence. Also, the ties many hackers have to AI research and SF literature may have helped them to develop an idea of personhood that is inclusive rather than exclusive -- after all, if one's imagination readily grants full human rights to future AI programs, robots, dolphins, and extraterrestrial aliens, mere color and gender can't seem very important any more."

Our quantitative research shows that Raymond is wrong on the numbers. The disproportionate dominance of men in the F/LOSS survey (Ghosh et al 2002), where hacker identities are by far more pervasive, was the reason for the study (see Aims of Research). When F/LOSS members discuss the absence of women, a popular explanation is that they are simply not interested. While there are social reasons why women tend not to show an interest (which will be explicated in the course of the report—see especially section 5), the link between early enthusiasm for technology use and the decision to enter technological professions is not an automatic one. Current trends indicate that while consumer usage is on the whole widening (Shade

2004, Sorensen 2002), this is not successfully bringing more women into the pipeline of ICT careers generally, as well as F/LOSS activities in particular. The proportion of women in ICT professions, both academic and commercial, is actually going down (National Science Foundation 2004, Sorensen 2002), which suggests to us that *the more significant factor is the hostile environment women face once they do get into ICT work roles. It is not that 'technical' jobs fail to appeal to women from an early age*. So few women in F/LOSS relative to other models of software production suggests that F/LOSS somehow exacerbates a hostile environment.

The ethical value system of the community is based upon what participants refer to as freedom understood in the notion of each individual´s possibility to choose. They thereby refer to the individual as the decisive carrier of agency. The community very much values the notion that 'anyone' can start tinkering (with software) and that participation is volitional. This starts with the users of F/LOSS who are given the choice of applications, provided with a maximum amount of configurability and equipped with the freedom of modification. The notion of choice becomes even more important when it comes to the producers of the software. Anybody is free to join and participate in a project or to start a new project out of an existing project's source code. Indeed with a social structure that relies heavily on voluntary labour there are no formal sanctions against those determined to participate in their own way. *From our informants' perspective the problem is not one of opportunities but one of choice.* As a consequence most F/LOSS participants think that it is the women who *decide by their own free volition* not to contribute. There is a strong desire to believe that gender has nothing to do with the choices people make because it threatens this notion of individual autonomy. This desire is not entirely limited to F/LOSS. In Nafus's study of a UK software firm (forthcoming), there was a near complete gendered division of labour. The (male) developers sat on one side of the room while the (female) testers sat on another, yet so important was the notion of individual choice that the whole office maintained that this was mere coincidence.

The overall agreement within the realm of F/LOSS production is that the best technical solution determines the further development steps within F/LOSS production. Therefore it is the people who have proven their abilities and who are

believed to be able to provide these best technical solutions who determine F/LOSS projects. Participants often refer to this form of political organisation as *meritocracy*. According to them it is a fair and equal way of coming to decisions since everybody has the means to provide the best solution: source code, mailing list archives and documentation of the technical tools needed to create software. Although many women do talk about the subtle ways that men made it difficult for 'just anyone' to contribute, from women's perspectives too the meritocratic ideal was not something they wanted to change.[2] But the men particularly felt that there was already equality of opportunity.

However women and men within F/LOSS do fundamentally differ in the way in which they participate. Both our qualitative as well as our quantitative research points to the fact that men tend to pick up the more prestigious technical tasks. Men are overrepresented in activities such as coding, testing, as well as reading and writing bug reports. All these activities are closely related to the production of source code. On the other hand women are more likely to engage in the less technical aspects of F/LOSS production. They engage more in documenting, providing graphics and sounds, moderating mailing lists and organising workshops. In most projects these activities are considered to be less crucial and are, therefore, less prestigious (see. 4.2).

As a consequence women feel that their work is less acknowledged than that of men. Almost 2/3 of all female participants think that it is easier for men to get acknowledgement for their F/LOSS contributions.

[2] Indeed one of our female informants working in the software industry sees this meritocratic model as a possibility to overcome a common barrier in the corporate business world which she described as a glass ceiling .

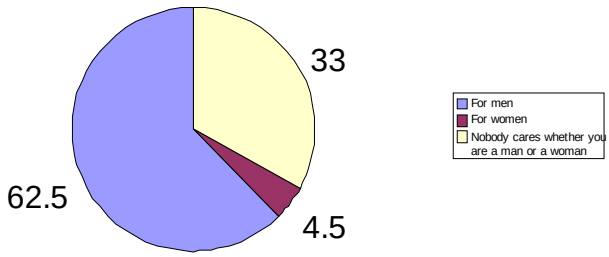

Figure 1: Survey response to the question: For whom is it easier to get acknowledgement for work in the F/LOSS community? (female respondents)

Interestingly more than 4/5 of the male respondents think that gender does not play a role.

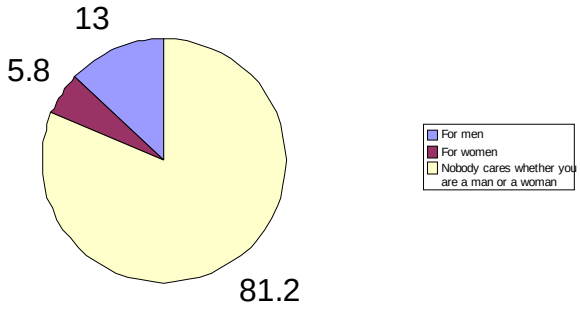

Figure 2: Survey response to the question: For whom is it easier to get acknowledgement for work in the F/LOSS community? (male respondents)

Participants of the F/LOSS community (male and female) do see there is a gender difference in the types of activity that people engage in. However they attribute this difference to individual choice and thereby make gender invisible.

Women's support activists have found that attempts to raise awareness about the issues facing women are taken as 'ungrounded' accusations, and the response within the community is usually that community members simply lack experience with

women. It is social incompetence, not deliberate exclusion. But over-riding this perception is the more powerful thought that in the end, technical skill is the crucial factor for inclusion, and thus the community is gender-blind in its significant practices.

Some people—both men and women—interpret the mere mention of gender as somehow 'reiterating' the 'artificial' differences between the sexes. This, for example, is taken from a F/LOSS blog posting:

> "I think the whole idea of 'Debian Women' is flawed. All it does is give / reiterate to people the idea that women are somehow different to men when it comes to computers and should be treated differently." [3]

And from the same blog…

> "Instead of saying "Linux geeks should be nicer to newbies," [the article] says "Guys should be nicer to women." No…to ask for different treatment for different genders is SEXIST, and when the stated goal is to minimize sexism, it becomes counter-productive."

Having made analysis of copious material collected during the study, we interpret these kind of (common) statements as follows. The logic goes something like this: if difference in technical competence is not biologically based (women can be as good as men at coding), then F/LOSS members interpret it gender in this context as 'mere' social conditioning, which for them constitutes grounds to dismiss it as not only arbitrary, but easily overcome through sheer individual volition. That is, women becoming technically competent and thereby disproving the biological basis for difference is the answer, and this is based on individual decisions by those women to devote themselves as men have had to.

[3] We would like to clearly mention that despite an initial period of doubt, discussion and reluctance from some Debian developers, the Debian Women project now gets support from some of its very senior male members. Participants in the project consider this support as crucial for the success of Debian Women to bring more female contributors into Debian.

However, our study also found that the attitude of some of the male F/LOSS participants towards women creates an atmosphere which can be described at least as not women-friendly.

Whereas most hackers see themselves as neither sexist nor hostile towards women there is a clear distinction on how women and men perceive and experience interaction within the F/LOSS community. We found that women and men evaluate the behaviour of male participants in the community differently. This is the case both for their interaction within the general F/LOSS universe as well as within the respective projects in which they collaborate. In our survey almost all female participants have observed or experienced discriminatory behaviour against themselves or other women in the general F/LOSS community, but only 1/5 of all men reported to have perceived discriminatory behaviour against women. Also within their projects more than half of the women observed or experienced discriminative behaviour against women, but only about one out of ten men had the same perception.

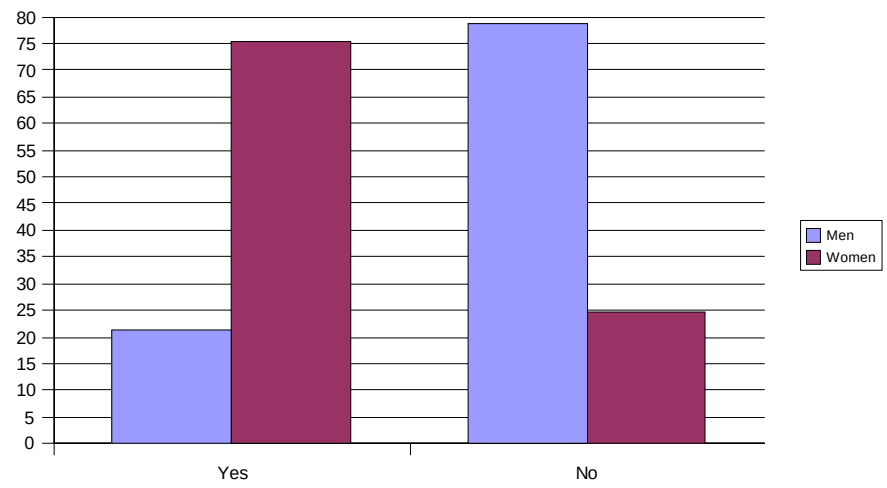

Figure 3: Survey respondents to the question: Regarding the FLOSS community as a whole, have you ever observed discriminatory behaviour against women?

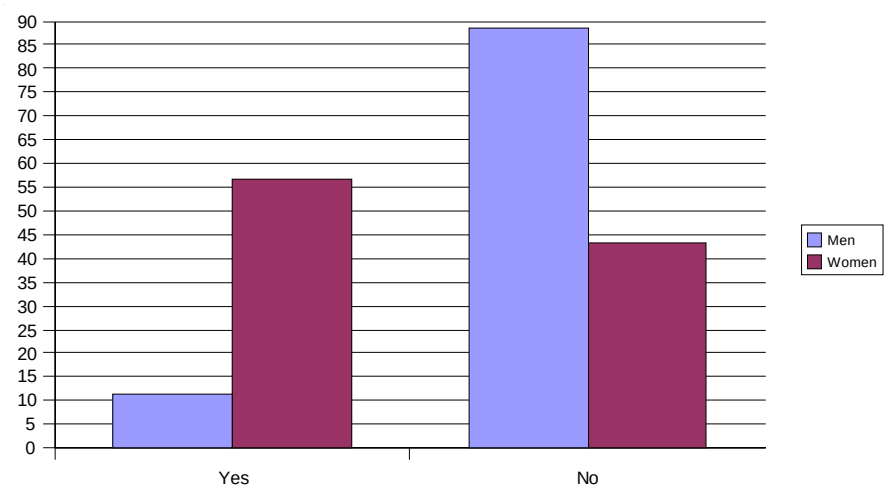

Figure 4: Survey respondents to the question: Regarding your collaboration with others during your FLOSS activities, have you ever observed or experienced discriminatory behaviour against women?

Derogative behaviour is often not understood as such. It is in many cases expressed in the form of jokes. At a large F/LOSS conference, for instance, somebody tried to motivate people to take part in a competition for a particular project by announcing the winning prize would be a date out with a beautiful, blonde girl. When a woman who attended the conference because she was interested in the topic of F/LOSS and wanted to get involved in it objected, she was misinterpreted. As a reply she only received: “Oh, this is just a joke.” However, it is this type of joke which make women feel uncomfortable in the community. Female informants often report misogynist jokes. One of our interview partners, for instance, reported an experience she had in an IRC channel:

> “One IRC channel I used frequently made jokes about rapes. I had a huge growl with somebody about this and I was a long time member in this channel. The joker was a newcomer and I personally think I have contributed a lot more than he had. At one stage he ended up telling me, if I couldn’t “stand the heat I should get out of the kitchen” and then I said, “What would you say for example if I said that I had been raped and I took exception to be used as a subject of humour?” and he said: “that’s too bad but, you need to learn to live

with it".

Another informant adds to the same topic women being subject of jokes:

> "Because even if you are joking, even if you think you are funny, she has heard it 15 million times before and it get's really boring really fast. And that's something that most of the guys [...] just don't realise about at all because [...] they have never asked how it is like to be in a less then half percent minority. And they just don't realise that making comments like that on channel or off channel is just really, really frustrating."

Contributors have talked about how this behaviour is as at odds with what they call their own 'ideology' or 'feminism'—e.g., the notion that women should have just as many choices in life as men. The 'inclusive' personhood that Raymond talks about in the Portrait of J. Random Hacker is inclusive of individuals imagined not to contain social (i.e. gendered) ties. The acknowledgement that there are gender differences in practice sits uncomfortably and is often perceived as divisive in itself, as we have seen.

It is this mixture of on the one hand valuing individual technical performance at all costs and on the other hand ascribing the reasons of non-involvement of women to their individual choice, which makes it difficult for women to fully take part in the F/LOSS community.

4.2 *F/LOSS communities actively perpetuate a 'hacker' ethic, which situates itself outside the 'mainstream' sociality, but equates women with that mainstream. Women are treated as either alien Other or (in online contexts) are assumed to be male and thus made invisible. Women are seen as innately more able to organise, communicate and negotiate among F/LOSS projects as well as with the outside world. Thereby they become carriers of sociality that is seen in a contrast the 'technical' realm ascribed to men. Additionally F/LOSS women receive a high level of attention due to their gender which decreases their feeling of acceptance as community members as well as their willingness to further engage with the*

community.

F/LOSS members more strongly associate with the notion of being a hacker than others working in a proprietary software environment. The term 'hacker' is certainly one of the most debated among members of the community itself and we would certainly not want to propose a distinctive category. Everybody we encountered during our research was able to define 'hackers' for themselves in contrast to popular notions communicated within the mass media: Hackers are not people breaking into computer systems to steal, corrupt or destroy data. These people are called 'crackers' by our participants. However there is a debate about a positive definition of what a 'real' hacker is. Eric Raymond's documents, already referred to, are the most commonly referred to within the community itself, and include the 'manual' 'How to become a Hacker', the 'Portrait of J. Random Hacker' (see above) and the 'Jargon File'. These documents have been criticised, mostly by older members of the community, who would not subscribe to Raymond's view. However Raymond's work is still considered by many as seminal on this subject and still does contribute hugely to an understanding of ethics within the community. Some of our more experienced informants described Raymond's work as influential and revealing when they first began to realise there was a distinct social group emerging. Whereas there are efforts within the community itself to unlock the term 'hacker' from Raymond's often elitist and libertarian avant-garde understanding, his ideas have, nevertheless, colonised the discourse and are still influential particularly among newer members of the community trying to find orientation.

In our context, however, it is important to understand that a hacker identity acts for many as a social model which largely corroborates other studies of 'hackers' (Kendall 2000, Hapnes and Sorensen 1995 Turkle 1998, Kleif and Faulkner 2002, Faulkner 2000). We must be clear that hackerdom is a model that both informs behaviour and serves as a tool with which people make sense of it, not an accurate evaluation of all persons at all times (see section 5). Hackers think of themselves as intentionally different from mainstream. Raymond states this clearly in the Jargon File: "[H]ackers

as a group are particularly creative people who define themselves partly by rejection of ‘normal’ values and working habits, it has unusually rich and conscious traditions for an intentional culture less than 50 years old.” (Jargon File Chapter 1) They have a clear idea of who is outside and who is inside. The inappropriate usage of slang is seen as an indication that somebody is not a hacker: “[N]ot knowing the slang (or using it inappropriately) defines one as an outsider.” (ibid) Counter terms such as 'suits' or 'wannabees' are used to distinguish 'hackers' from the mainstream.

In the hacker model gender performances are also performances of alterity. The masculinity performed in F/LOSS is a very specific kind of masculinity. It defines itself in contradistinction to ‘hegemonic masculinity’ (Kendall 2000) or what participants read as ‘mainstream’. This constitutes a vocabulary of embodied interactions, both in terms of interacting with the computer and bodily markers of alterity. For example, in the Paris fieldwork about half of the male F/LOSS participants we encountered during our research had beards or do not shave daily – far more than the average of men in Paris. During meetings and conferences there are many participants who come in T-Shirts, jeans and trainers, which in Paris is not common attire among professional people. There is a performed differentiation in style. On the other hand the T-Shirts often express people’s affiliation to a specific software project or advocacy group. This dress code is adapted by women active in the field as well. During our fieldwork we have encountered many women who dress accordingly. For women, there is an ancillary effect, however. That is making gender difference as invisible as possible. One of our informants described feeling a strong pressure to make herself invisible as a woman in the very male environment of her computer science education:

> “At the beginning I really had a hard time coping with that. One was looked at whenever one wore tight clothes or comments were made when one wore a short skirt.”

Another female participant describes a similar experience:

> “I was always in groups of boys since I was little, I was trained to be one via osmosis in a certain way. (...) I know how this works in professional and friendship relationships, etc. because I was basically transparent as a girl in groups of boys. I was not a girl. ... [T]here was a very violent environment

> where one had to be either engendered male or well neutralised. (...) This concerned clothing, make up, and everything which was perceived as signs of female seduction in our society."

In our fieldwork we encountered many women dressing or behaving in what they describe as a "male" way. What seems like a precondition for women to take part in the F/LOSS universe acts as a barrier for women who do not abandon signs of femininity. Female informants reported psychological pressure women did face in their computer science classes to submit in such de-gendering process.

This very particular alternative masculinity is performed as a type of alterity. Similar to Hapnes and Sorensen's findings on Norwegian hackers (1995) this alterity is used to confirm each other's individuality and uniqueness, in contrast to both a rather mysterious 'all-maleness' of 'mainstream' men as well as to an assumed femininity. It is often part of free software hackers' biographies that during childhood and adolescence they had been different to other members of their age group.

Male F/LOSS participants often describe this difference as a lack of social competence and interest in different activities than mainstream people. For some people F/LOSS seems to provide a platform on which one could stand outside the social constraints of 'mainstream culture'. For them F/LOSS is an environment in which common rules of courtesy and accepted forms of communication – as a form of sociality – do not necessarily have to be fulfilled (see section 4.5).

On the other hand "being social" is something which is ascribed to women in a somewhat naturalising way. Women are perceived as, and made to be, carriers of "sociality" in that they are expected to be more sensitive and able to deal with other people. One female participant described that effect in the following way:

> "There is always the danger that you get reduced to that in the sense 'Get women into your project because they know how to calm people down. They are nice and can do all the diplomatic stuff. They will make your project nice. Women always pick up the mediator roles.' Women tend to do that. They tend to mediate in between people in the form of: 'I am sure that he did not mean it that way. Try it again.' Typical female role. Yes, we do that, and we do that quite successfully. But this won't be new to come up. It

> is not about bringing women into projects to make projects nicer. This is again reducing women. Of course women do not have better social skills but they are probably more interested in keeping things in harmony."

Women are constructed as a foil in imagining what it means to be a hacker. They are perceived as carriers of sociality, which shows up hackers' own displays of wilful social 'incompetence'. Interesting here in particular is an understanding of a `technical´ sphere that is separate of a `social´ sphere. Whereas the men's role is typically in the former, women are understood as being active in the latter.

Within the community it has been often commented by both men and women that if hackers could learn the 'rules' of social interaction—e.g., interaction with both 'mainstream' men and women, that the chilly culture facing women would be alleviated. Although the 'remedy' is not at all a simple solution, it does demonstrate just how interlinked concepts of gender and concepts of alterity are in this community.

These findings are not independent of other research. Some studies of women in computer cultures, such as Turkle (1998) and Wilson (2003), point to how women on computer science courses use their social connections with others to actively contrast themselves with the men on their course, exaggerating the lack of men's social ties. These women highlight the long hours at the computer without any 'social' interaction as an unsavoury aspect of computing.

This way of constructing women as carriers of social relations sets up the basis for the discriminatory environment women face. It limits the roles they perform within F/LOSS (see section 4.3) and turns experience gaps into a serious obstacle (section 4.4).

Women in F/LOSS, as in other areas of science and engineering, face an enormous amount of sexual attention. In our survey we found that almost half (48 %) of all F/LOSS women have been asked out on a date by other members of the community, 11% 'often' (See Figure 6).

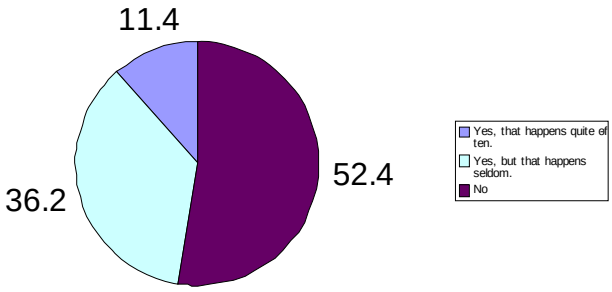

Figure 6: Female survey respondents to the question: Have you ever been asked for a date by a F/LOSS participant?

What is perhaps even more telling is that 2/3 of women and men think that it is very or mainly true that in online contexts women receive more attention because of their gender than as a F/LOSS contributor. In offline contexts women feel this attention even more. More than ¾ of all women think that it is very or mainly true that they get more attention as a woman than as a F/LOSS participant. (see Figure 7 and Figure 8).

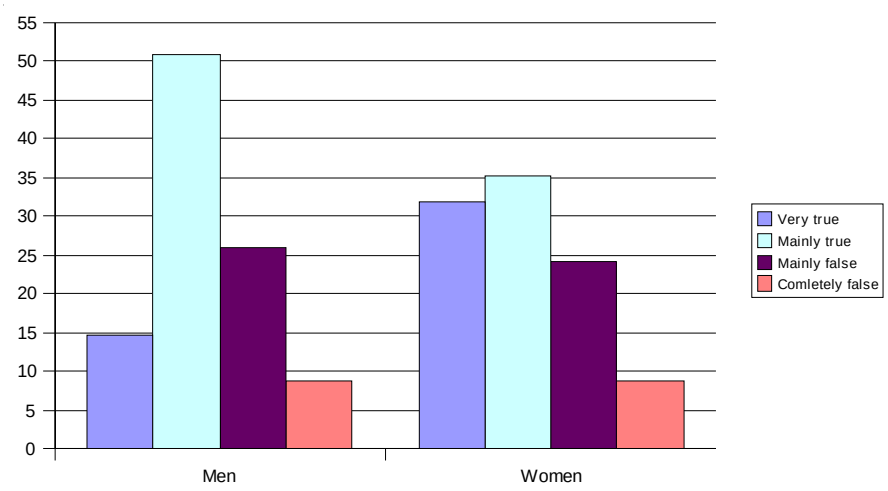

Figure 7: Survey respondents to the question: In online contexts women often get more attention as a woman rather than a F/LOSS participant.

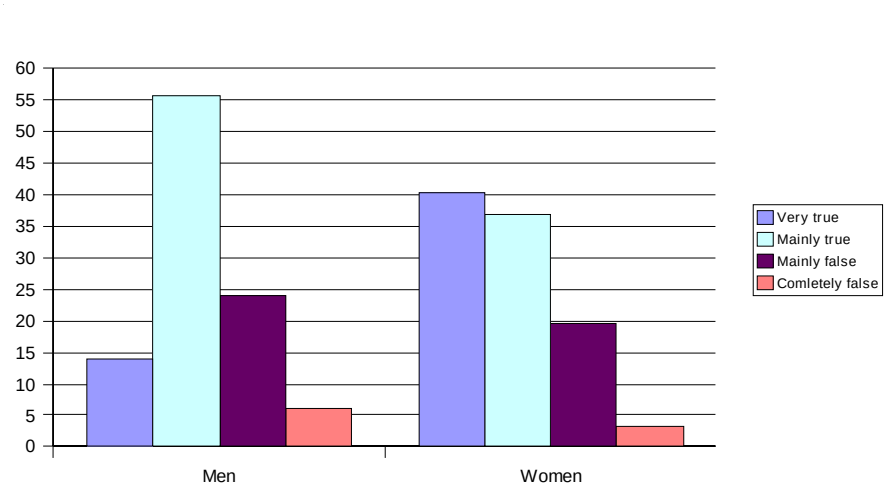

Figure 8: Survey respondents to the question: In offline contexts women often get more attention as a woman rather than a F/LOSS participant.

These numbers resonate with the ethnographic work, where women related their experiences of prolific sexual attention, and men too relayed to us their observations about how women are sexualised in F/LOSS. While there are examples of outright offensive online postings on F/LOSS websites such as Slashdot, what seemed more generally off-putting was the way in which the perception of women as carriers of sexuality makes them feel alien and Other. Similarly, the authors of the 'HOWTO Encourage Women in Linux' website actually felt the need to remind men to refrain from pointing when a women comes along to meetings.

Not only does the frequency of sexual propositioning make women feel alien, but it can disrupt mentoring relations and communication in general. Some women reported that in situations where there is idle chat, it was quite common that as soon as it becomes evident that a woman is not interested in a sexual relationship, that men often lose interest in building up a rapport.

The women reporting these problems already inhabit and identify with highly masculine social worlds. Often it is the same women who in interviews tended to say that they usually have more male friends, and who quite vocally reject 'stereotypical' female activities and ways of self-presentation. For example, not having played with

Barbie as a child was often spoken of as a point of pride. Consider this excerpt from an interview with K.:

> "I actually did not look for a women's project because I felt quite comfortable within the normal community. I had normal user problems. You get in contact with people and at some point it becomes clear that you are female and the conversation changes. It never bothered me. I just thought that there are some weird people everywhere so I did not feel completely disturbed by that. But I think it does keep other women from doing Linux stuff because of these experiences."

Even someone like K., who is normally quite comfortable in the F/LOSS environment, still feels the terms of relationships shift once gender becomes apparent. When gender becomes apparent, it begins to dominate relations. In these circumstances, when 'jokes' about sex or gender are made, *even if the intention is not to exclude or harass, they nevertheless have that effect* (see section 4.1).

Women not only get attention as women in a sexualised sense. Some of our female informants also reported being placed in motherly roles and asked to give advice 'as a woman'. Furthermore we have been told by some female participants that they have been repeatedly consulted for dress advice by complete strangers. As K put it, : "I don't mind giving these tips once in a while. The problem is only that once you have done so a technical discussion is thereafter rarely possible."

4.3 F/LOSS rewards the producing code rather than the producing software. It thereby puts most emphasis on a particular skill set. Other activities such as interface design or documentation are understood as less 'technical' and therefore less prestigious. This has consequences both for the lower valuaion of activities in which F/LOSS women often engage as well as for the software itself which often is still oriented more towards the developer rather than the user.

The surest path to authority and reputation building in F/LOSS is through what participants often describe as ‘technical expertise’. Although career paths vary substantially, many programmers start with submitting bug fixes and coding small features. Non-coding work, such as documentation, is often treated as an afterthought within F/LOSS projects. There are, however, notable exceptions such as the desktop project KDE and the Linux distribution Ubuntu, which have started to make use of the fuller repertoire of skills (see section 7). Although it is problematic for many to acknowledge, many women do find themselves in roles related to documentation, organisation and advocacy (see section 4.1), which deprives them of the gravitas associated with ‘technical expertise’. It is very difficult in this community to move into significant and accepted leadership roles without having demonstrated technical prowess first.[4] The inequality can be seen in just how often it requires heavy lobbying by a documenter to have a developer change code. One of our informants, a documenter with the GNOME project, reported that she goad a developer with the possibility she would describe a programming bug in the documentation before the latter was motivated to change the code.

In this way, code acts as a symbolic proxy for ‘technical expertise’, which in turn defines what is worthwhile knowledge (see section 5). Other forms of knowledge such as the ability to write comprehensive documentation or to provide good translations are comparatively underrated.

While this construction of 'the technical' is also largely the case in proprietary

[4] There are a couple of exceptions, for instance in the Mozilla foundation or in the KDE projects where people with no coding contributions attain leadership positions. Interestingly in both cases these have been women.

software, in the commercial world there is a heavy obligation to produce a final product, and therefore documentation and usability work cannot be dispensed with easily. However, in conditions of 'scarcity' it is the first thing to go. "Making the thing work" is prioritised over "making the thing work for a user". Kendall (2004), for example, found that as 'dot com' occupations grew into specialisations, men used technological imagery to define their work, leaving them with a much greater say in the final product. In the dot com crash, the supposedly 'softer' skills of web design was excluded from the shrinking job market, and the proportion of women in IT declined as a result (see section 5). In F/LOSS, projects often stay at 'proof of concept stage' (see Comino et al 2005) in part because frequent scarcity of resources prevents projects from paying for the polishing work[5], but more importantly because the value system in the community encourages participants to consider this kind of activity as less worthwhile. In a community which up until very recently consisted predominantly of people with programming skills this value system motivates 'technical' coding activity and discourages other tasks within the software production.

One reason that these other skills are less valued is because many people understand them as innate aptitudes rather than as skills acquired through some effort. This reading is a direct result of the way in which women are connected to understandings of the social. Women are seen as 'naturally' able to communicate, and any demonstrated ability to communicate with non-hackers is used to confirm this supposed naturalness. Woodfield (2000) describes a similar dynamic in the proprietary world.

We are aware of a contradiction here. Women are seen as unnecessarily constructed as different when it comes to the meritocratic sphere of coding itself – there is no reason why they should not succeed as men do, yet in other F/LOSS spheres, their natural difference from men is assumed and acted upon in the interests of a certain group (coders, men).

There is a circularity to this sort of exclusion. Because so much of the software is constructed for use by developers, the full range of software design possibilities is not

[5] Although in the case of the Ubuntu project this work is indeed partly funded (see section 7)

in practice explored, and therefore only a narrow skill set is imagined to be sufficient. In Comino, Maneti and Parisi's (2005) study, only 27% of projects found on SourceForge—the largest resource of open source software—were aimed at end users. A similarly small proportion of programmes make it past proof of concept stage. Historically, F/LOSS community membership has come through use: users test software (which in the world of F/LOSS normally requires a highly detailed technical knowledge) and file bug reports, eventually learning to submit their own bug fixes. These users are limited to those that already have a good deal of computing knowledge. Linux platforms used to be so difficult to install that the community organised install parties, where would-be users bring their machines to one location for assistance with installation and configuration. Install parties are one way of bringing users into F/LOSS and are necessary due to the difficulties of changing the software to meet their needs as-is. Similarly, the Debian Women project explicitly aims towards supporting integration of female Debian users into the main Debian project through skills development, not producing 'women-friendly' software separately.

In the absence of widespread support efforts, the way in which prioritised coding makes its way into software design works to keep the group endogenous. Without newcomers homogeneity is largely replicated. While recently there have been more efforts to change this design bias, in a community that values coding above all else, designing usable software suggests something about (gendered) identity. It invites the connotation that things must be 'dumbed down' for neophytes to take interest. The remedy is located in changing the skills of the user. This takes on subtly gendered overtones, and reproduces the notion that hacker masculinity is too clever to engage with the mainstream. For example, Ratto (2003) demonstrates how levels of skill amongst users are imagined on gendered terms. "Aunt Tillie" is common jargon for the archetypal non-technical user, one's elderly and scatterbrained maiden aunt who downloads knitting patterns, who does not grasp the difference between network speed and processor speed. "Getting to Aunt Tillie" represents the mainstreaming of F/LOSS. But as some members have pointed out, this is a tautology: if Aunt Tillie has installed Linux herself, she is not Aunt Tillie. Ratto goes on to report various other fictional personas used to imagine gradations of masculinity/femininity and expertise,

which fit on a sliding scale.

There is yet another element in the relationship between design and homogeneity. Historically, women tend to include in their narratives about their interest in computing some sort of instrumental gain that software makes possible. While they report interest in problem solving and scientific curiosity in the same way as men do, they tend to also include this facet. While this instrumental aspect has often been reported as 'computational reticence' (Turkle 1998, see section 5)—i.e., denigrating it to just a tool rather than a celebrated locus of pleasure—this element only implies reticence for some. For others it is just as much a source of interest and excitement. F/LOSS, however, used to develop software for a closed circuit of software developers. Ironically, F/LOSS communities claim to build a set of technologies for the public good (as opposed to proprietary gain), yet have much more difficulty coping with the needs of a greater public, compared to proprietary software.

In these ways 'openness' in F/LOSS is a misnomer, as the community is highly homogeneous in its production practices. Often it is almost as if software projects are not about software production but about code production, where members imagine that within code lies exclusive access to worthy knowledge. In this sense, F/LOSS resembles academic computer science more than engineering. It is perhaps not a coincidence that proportions of women in F/LOSS resemble academic computer science numbers. However, there are plenty of examples which demonstrate that coding is not the only way of being technical (see recommendations).

4.4 F/LOSS production and infrastructure is designed and built assuming contributors have a long history with computers, but women tend to engage later in their lives with computers. In order to join women have a larger amount of catching up work to do, which they must do in an environment that almost exclusively values independent discovery.

Lin (2005) argues that a major contributing factor in the exclusion of women in F/LOSS is that most coding is done from the command line rather than through a graphical user interface (GUI). So women tend to enter computing as a result of formal education (see also Margolis and Fisher 2002), which teaches using GUIs. However, we suspect the greater problem lies with the length of computer experience. Our survey revealed that women who are in F/LOSS have shorter computing histories. Whereas men started using a computer at an average age of 12, women start using computers at 14.5 years. Similarly our male participants owned their first computer at the age of 15 on average, whereas women had their first computer at the age of 19.

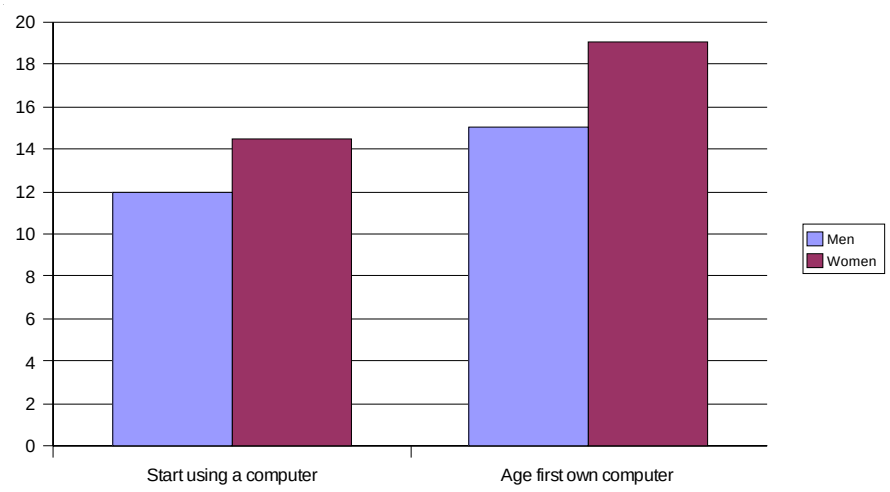

Figure 5: Survey respondents to the questions: “From which age onwards did you use a computer?” and “When did you have your first computer of your own?”

Early computing experience does not predict computer science success (Margolis and Fisher 2002). The issue is not one of straight expertise, but the way in which some sorts of backgrounds are made into prerequisites (see section 4.6), which translates into additional burdens. In contrast to computer science courses which start from the beginning, and assume no knowledge, F/LOSS participants are normally assumed to

already have the knowledge at hand before entering a project. It means women are more likely to have to ask questions more frequently than their male counterparts, which is a problematic thing to do in a social world that rewards technical expertise and autonomy, flaming (see section 4.6), and uses reputation as its generalised currency.

There is some reputational advantage to be gained by showing oneself to be more expert than others, but how this is performed qualitatively is equally significant. A rude way to express impatience with an ‘easy’ question is to say that the person should RTFM (read the f***ing manual). Interestingly, rude responses are often given by people who are in the process of gaining a reputation. It is often as if lower ranking participants try to build their reputation by either responding rudely and thereby implying impatience with the ignorant, or by showing off the extensiveness of their knowledge, instead of providing an uncomplicated answer. For people entering the community this dynamic is not easy to recognise and they often ascribe the impatient responses they receive as a function of their own lack of knowledge.

Most of our informants taught themselves by reading manuals and books from a very young age, which they interpret as a kind of independent auto-generation of knowledge, rather than a communication between author and reader.

In respect of the assumed auto-generation of knowledge, we found gendered differences among our participants. Whereas most men remember their first learning steps into computing as a form of solipsist interaction with the machine assisted with manuals, women often refer to an interaction with human beings (family members, friends, teachers, courses, etc.) as a way into computing. Also during their participation in the F/LOSS community women more often visit technical conferences and workshops.

What is at stake is far more than asserting hierarchies between newcomers and experts, but creating norms about the precise way in which one should acquire knowledge. Asking ‘easy’ questions violates these unwritten models and is interpreted as a lack of independence. The issue surrounding the GUI vs. command line, then, is

not a mere matter of ‘women-friendly design’—a notion which must be used with the greatest of caution. In fact, it makes evident an insiders’ model of understanding experience and learning, which in turn *makes* the ‘experience gap’ significant.

4.5 Inflammatory talk and aggressive posturing (‘flaming’) is accepted within many F/LOSS projects as a key means of developing reputation. Whereas more established F/LOSS members engage less in ‘flame wars’, people still establishing their reputation often use them as a platform to make themselves visible. This is often off-putting for newcomers and less experienced contributors who are not yet familiar with the community, its norms, or its real hierarchy. The effect is particularly pronounced in the case of women, who in most cases have a shorter history in computing and therefore less confidence in defending themselves on technical grounds. ‘Flaming’ thus exacerbates the confidence difficulties women tend to have as a result of lower levels of previous computing experiences.

Although it is considered ideal that good code would speak for itself, in reality authors must vociferously defend their work or proposals in order to demonstrate knowledge and develop a reputation as a valuable person. Demonstrating and defending one’s technical proficiency is vital. Sometimes a tiny technical decision results in a discussion consisting of several hundred emails. The discussions tend to become more fierce as they progess.

M., one of our informants described this dynamic in the following way:

> [P]eople in the free software community think that technical correctness is the most important thing. We should do whatever is correct technically. And once you get into the idea that technical competence is what matters it becomes a lot more acceptable to have arguments, quite vicious arguments over technical questions because the most important thing is the technical

> solution is the best. So if you have a big argument it does not matter. But not everybody wants to have big arguments over technical details. (...) People get emotionally attached too and if they feel that their position – and to some extent their credibility – if you attach that to a technical decision and other people disagree with, then losing the argument makes it look like you are wrong to have that position in the first place. This implies that you are less competent to make choices in the future. (...) The stronger the argument gets, the worse you feel if you loose. And so you are willing to put more into the argument. So it just gets worse and worse and worse. But instead of making a nice and simple technical decision you are involved in a 200 message flame war. (...) And if you have such a way that technical decisions are made by that sort of argument then it means that if you are not getting into that sort of argument you are contributing less to the decision making process and you won't get as high in the recognition within the project. You are less visible. There is a pattern that people who get on quietly with stuff are less important within the project. Theses are people who are not remembered. They are not people you think of.

In some cases participation in such discussions seems to be even more important than actual production of code. We have found cases where people who do contribute a great deal but do not get involved in flame wars are perceived as less knowledgeable. On the other hand people who often engage in flame wars become visible both to people within the project, but especially to people who are in other projects or even outside the F/LOSS community.

M. agrees with our observation:

> “There are some people in the community that get involved in these arguments that aren't any developers. Some of them actually don't contribute anything to the project. To be honest it is difficult to describe them as members of the community. Sitting on IRC and mailing lists having these arguments does not make the community better. Actually doing something useful makes the community better. In theory people always talk about free software being a meritocracy. I think that is not how it works. I think I could argue that it is not a meritocracy. It isn't. It is noisy people that get recognised.”

There are mailing lists as well as IRC channels which are known as inflammatory and hostile. More experienced participants often avoid these environments and discuss the relevant issues at other forums. These lists and channels are, however, often not listed

on the projects' websites and are therefore not known to less experienced people arriving newly at a project. Newcomers are often quickly deterred by the atmosphere of inflammatory talk and turn the back to the projects all together. Krieger during his fieldwork often used contacts to knowledgeable people he encountered outside the community to ask the 'silly' questions. This is a form of behaviour we found often with our less experienced informants. One of them described it in the following way: “I ask the nice people I know the stupid and easy questions off list and only post the difficult and good questions on mailing lists and IRC.” This is, however, only possible if one already knows people who can answer these questions. Asking easy questions are often rudely answered by ‘Go and google it.’ Or the questioner is referred to rather intimidating documents such as the ‘Howto ask a Question’. This behaviour is off-putting to all newcomers, but even more to women who often already feel outsiders. It is not random that many of the women advocacy groups take up this point. They all have a 'be friendly' policy to newbies and 'silly' questions. Groups like grep!grrls make it clear that there is not something like a 'too silly' question.

While there is scholarship that argues that online communication lends itself to flaming and other forms of women-unfriendly speech (Scott, Semmens and Willoughby 2001, Michaelson and Phol 2001, Herring 1996, and Winter and Huff 1996), in F/LOSS flaming is particularly rewarded and has a particular rationale. In addition, flaming contributes to the notion that there is a dualistic right or wrong, because flames are carried out until one person backs down. It is also reinforced by the idea that as a non-mainstream grouping which dissociates with ‘being social’, concern for the feelings of others can be disregarded.

However, women consistently tend to underrate their skills, both in F/LOSS and elsewhere (Wilson 2003, Margolis and Fisher 2002, Tierney 1995). It is widely recognised (first identified in Turkle 1998) that when women learn to program they are more inclined to gather as much information about a programming problem first rather than jumping straight in with an attempt at a solution. However, key aspects of software programming prevent them from ever developing the confidence that such background knowledge would afford. No one can claim absolute expertise in such a wide and rapidly developing domain (Downey 1998 and Ullman 1997). The field

changes so fast it is not as if expertise can simply be developed through seniority and experience; rather, it is a constant game of chase to, on the one hand, be seen to do ‘edgy’ stuff (the most technically advanced and therefore the most prestigious), and on the other hand to conceal what is unknown. In a context that rewards visible criticism, such a chase proves particularly problematic for either the less confident, or for those who find ‘winging it’ disingenuous. As one woman put it, “nobody ever says you can’t do something but you are always scared because there is always some missing knowledge.” That women often greet this missing knowledge with fear rather than excitement and pleasure reflects not just low confidence levels after moving into F/LOSS, but the very real prospect that leaps into the unknown will be met by inflammatory criticism. Similar to what Margolis and Fisher (2002) found in their study of computer science students, this leads many F/LOSS women to question whether their interests and talents really do lie in F/LOSS.

4.6 *The reliance on long hours of intensive computing in writing successful code means that men, who in general assume that time outside of waged labour is ‘theirs’, are freer to participate than women, who normally still assume a disproportionate amount of domestic responsibilities. Female F/LOSS participants, however, seem to be able to allocate a disproportionate larger share of their leisure time for their F/LOSS activities. This gives an indication that women who are not able to spend as much time on voluntary activities have difficulties to integrate into the community.*

Both F/LOSS men and women are highly active in taking part in the monetary economy either by self-employment or salaried work. Less than 1/5 (18.6%) of all F/LOSS participants do not work either due to unemployment or because they are students, or because they are stay-at-home spouses. There is no significant difference measurable between men and women in this figure. Similarly there is no significant difference measurable in terms of the monthly income.
However men and women do engage in different aspects of the monetary economy.

Whereas the share of men in the areas directly related to computing (programmers, software developers, network administrators, database administrators, web designers) is almost 2/3 (65 %) there are less then half of the female F/LOSS participants (48 %) working in this field. Women tend to engage professionally in other fields. These figures are not surprising considering the kind of activities women and men engage with within their F/LOSS participation (see 4.2). Taking into account that technical computing jobs tend to be towards the upper end of income scales these figures confirm our impression that F/LOSS women who do not work on technical computer jobs are in more senior positions. This can on the one hand be explained with the fact that F/LOSS women are older then F/LOSS men (median age of F/LOSS women is 31 compared to 29 of F/LOSS men), but also be attributed to the fact that more women in F/LOSS are formally educated. Whereas about 25.5 % of the male F/LOSS participants do not hold a university degree there are only 13.8 % of F/LOSS women do not have a degree. At the top of the education scale there are about 1/3 more women holding a PhD than men in F/LOSS(see Figure 9).

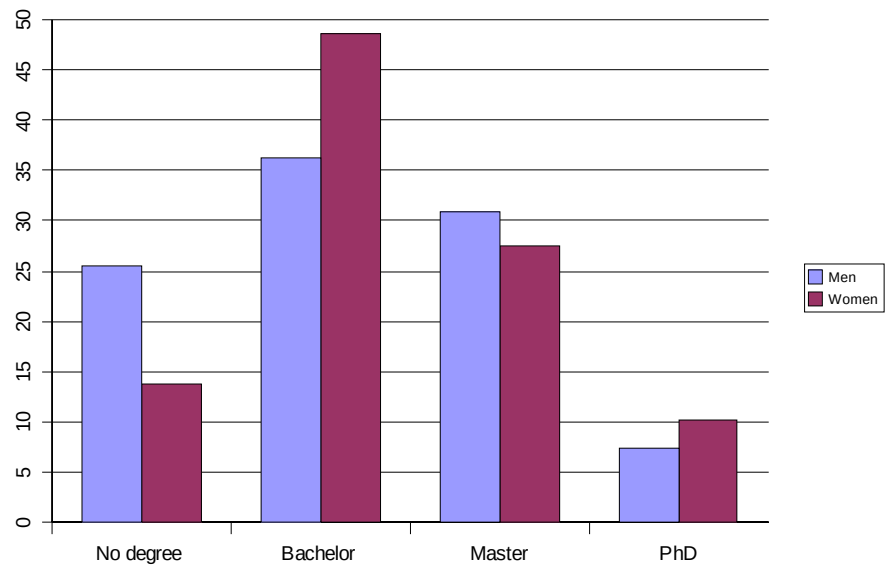

Figure 9: Survey respondents to the question: What is the highest level of education you have completed?

There is a large sociological literature proposing that women continue to do more housework than men (see e.g. Shelton & John, 1996 or more recently Bianchi et al, 2000 for reviews). However when we asked our participants how often household responsibilities kept them from their F/LOSS activities we did not find a significant difference between men and women.

As we expected, men and women do have different amounts of spare time available. Our survey showed that male F/LOSS participants on average have 20 hours of spare time (median) available per week whereas our female respondents only can spend 17.5 hours (median) on their leisure activities. Nevertheless this did not keep F/LOSS women from taking part in F/LOSS activities. Both men and women stated that they spend an average of five hours (median) of their spare time for F/LOSS activities. Also other time indicators such as the time spent within the last week for their main F/LOSS project do not show any difference.

When it comes to the professional engagement in F/LOSS activities we found that women and men do spend the same amount of time. Considering that professional F/LOSS tasks, up until very recently, were almost exclusively technical activities (which are less carried out by women – see above) it would seem that women get into F/LOSS jobs through the increased involvement of large software corporations running their own F/LOSS projects for profit (see section 7).

Taking these results together we find that women who are involved in F/LOSS are high-level professionals, often working in senior positions and are more highly educated than F/LOSS men.

What we have described is the socio-economic situation of many women who are in the community. This very particular situation also tells us something about the women who are *not* in the community.

The fact that women have a similar income compared to men is particularly interesting. The literature on women in IT professions says that we should expect a

shrinking pipeline (Camp 1997) where women drop out as their career progresses, leaving an overrepresentation of inexperienced women and a high amount of personnel turnover. Historically in IT, as elsewhere, women are paid less than men for similar roles (Faulkner 2002) and are overrepresented in low-prestige roles (Ranson and Reeves 1996). In turn this suggests that it is more difficult for women who are less experienced or are in less senior professional roles to engage with the community.

F/LOSS women do have less spare time available. Nevertheless they allocate a proportionately higher amount of it engaging in F/LOSS activities. Many of our informants, however, reported that participation is particularly difficult for women with family duties and many of them drop out. Women who do code tend not to have children, and some men with children have decreased their involvement with the birth of children, as have women. However, the construction of 'free' time again gets back to issues of identity and individual autonomy. Long sustained periods of programming is both an element of everyday practice and culturally perpetuated as an ideal in widely read documents such as Portrait of J Random Hacker. Many F/LOSS participants who are involved in the technical aspects of the movement draw on hacker identities, distinguishing themselves from others and the mainstream through sheer obsessiveness. The hacker model of writing code involves spending marathon-length hours working 'close to the machine' (Ullman 1997), which is a problem for people with interests or obligations outside computers. Similarly, in Margolis and Fisher's study of computer science students at Carnegie Mellon University, 69% of women believed themselves to be different from the majority of their peers in that their life did not revolve around computers, compared with just 32% for men. This suggests that there are less women likely to engage in a community which perceives computing as a value which drives out all others.

The long hours serve as a demonstration of independence and enthusiasm; it is a symbol of severed ties and not 'having a life' outside computing. This is related to the way in which having social ties and technological interests are seen as mutually exclusive (see also Faulkner 2000), which in turn draws on longer standing cultural tropes of the unencumbered explorer as the model for pursuing knowledge. For

example, scientific careers still largely assume periods of long, unbroken intensive study (Wajcman 1991). If one is not as single minded, then it is all to easy to begin questioning one's aptitude and interest level. Some of our female informants described the necessity for this focus and also refer to the need to 'catch up'. L. who is a female contributor to the Debian project described that in the following way:

> "In order to catch up in all the knowledge I have missed in terms of general free software experience, in terms of computer experience and in computer science degree kind of stuff it had to be a way of life. (...) [I]t is very off-putting if you can't make it your way of life. I was lucky because I got involved in a stage I could by going to the university, but it would be very hard to get involved at the age of say 30 or age 40 when you have plenty of other commitments. So I think that this is something worth thinking about. Because many people, many guys at least when they get involved in free software and computers it really is a way of life for them. And this is still the dominant way of getting involved in this stuff. But it makes it very hard for people for whom it is not a way of life to get involved."

There are many couples who share an interest in F/LOSS, and some report that the ability to empathise with the level of obsessiveness required has helped enable continued involvement. L. described the relationship she had with another F/LOSS hacker:

> "It [coding] took up all my time, all my thought, all my energy. And if there was somebody else who was also interested in the same things it was fine, it was a shared interest. It was something we could do together. If I would have been going out with somebody who had just nothing to do with that than I would not have had time for that. Everything I was reading, everything I was thinking had to do with computers. (...) One year Valentine's day was spent taking apart a computer, sitting on the floor eating pizza, installing something on it, I think it was Net BSD. Everything was to do with computers. Absolutely everything."

5. Discussion in Relation to Relevant Literature

Throughout this report we have made claims about the way in which gender is constructed, but we have yet to unpack what this term actually means. The current gender and technology literature expresses a clear preference for social constructivist approaches. These approaches suggest that the question of why women are 'absent' from technology is in fact the wrong question. Instead they seek to demonstrate that the very concept of technology has been defined as 'that which men do.' It is quite easy to see this historically. In medieval Europe, women applied mouldy bread to wounds to help them heal, which proved a rather effective vehicle for what would later be known as penicillin. Both amongst contemporaries and in histories of technology, this practice was dismissed as mere craft, while men's fumblings with leeches and medicinal prayer were reported as precursors to modern medical science. This is not just a matter of revising historical accounts; there have been ample studies, both historical and contemporary, which have shown how technologies stop being seen as technologies once women have access to them. Kotamraju (2004), for example, shows how the skill of web design was demoted to a 'non-technical' status as it became a way in which women described and approached their work. In the dot-com bust, men who already saw themselves through a technological paradigm called themselves 'systems administrators' or 'web developers' and were able to edge out female workers for scarce jobs.

The term 'technical' has an illocutionary ability to define not just what is masculine, but also what is a central or important activity. Social construction points to the way in which gender is reproduced actively in new settings as they evolve, and is not simply a legacy of the past. In this sense, to ask why women are excluded from technology merely points to a tautology.

This confluence of technology and masculinity is about practices of identity, or what Cynthia Cockburn (1991) calls "technology as masculine culture". However, concepts of identity are somewhat contested. The notion of gender stereotypes often used in positivist social science implies that there exists some context-less imagery,

unbounded by the relationships and configurations of power that instantiate it, which people slot themselves into like so many choices on a bookshelf. What is meaningful about ‘stereotypes’, however, are precisely the relationships that bound their performance and the power dynamics at work in this wider context. A ‘stereotype’ is never unchallenged received wisdom, but is a set of performed identities (Butler 1990) that must be re-produced. There has been a shift away from thinking of men and women as respectively homogenous categories, and a greater interest in masculinities and feminities in the plural. Hacker masculinity, for example, is performed in relation to other styles of masculinity as well as femininity (see section 4.2). Much about hacker masculinity is multivalent: they see themselves as competitive but collaborative, they control and manipulate the machine, but are artistic and interactive, playful but practical, they strive for individuality but also recognition as a community. Computers as well as masculinity are constructed as sufficiently flexible to allow these contradictions (Hapnes and Sorensen 1995).

There has been a recent push amongst scholars to move past thinking in terms of dualities. While ideas about masculinity do rely on femininity, and at the same time there is enough multi-valence to make it difficult to talk in mutually exclusive terms. For writers such as Donna Haraway (1991), both gender and technology are about ambiguity, and problematically so. She celebrates tropes of contamination and pollution. Authors commonly talk about co-construction of gender and technology, meaning that artefacts are used to articulate and display gender, and simultaneously these ways of doing gender are built into the design (Gill and Grint 1995, Adam 1999, Green and Adam 2001) and even spatial arrangement of the artefacts (Wakeford 1999).

It has recently become fashionable to talk about ‘plurality of genders’ as way of getting past dualities, but in doing this research we found that plurality and multivalence was, in a sense, part of the problem. Hacker alterity very much sets itself against other types of masculinities that position women as mainstream and therefore Other. Also, the equivocation that some men expressed about being a hacker, and the contextual ways in which hacker tropes are invoked, directly contributed to the perception that exclusion had nothing to do with one’s own actions. Ironically, the

post-modern tactic of seeing the social world as a construction was in part a way to unsettle its naturalness, and thus invite its undoing. Yet its very 'unnaturalness' is, for F/LOSS members, grounds for dismissing gender as mere social conditioning (see section 4.1). Instead, they locate the problem with unduly 'inflexible' women. The very real flexibility in identities contributed to the ongoing invisibility of gender issues.

6. Discussion of Recommendations

6.1 General Discussion of Recommendations

F/LOSS still is a predominantly European approach to produce software. Again our survey showed there were more than twice as many participants from European member states compared to the US. This is in line with previous research undertaken in this field (e.g. Ghosh, Glott and Krieger 2002, Robles et al 2001). F/LOSS is a major motor for technological innovation and development and is becomeing more and more relevant in the competitive field of commercial software industries (see section 7). F/LOSS already contributes considerably to economic growth in the field of information and communication technologies. This is important for larger corporations, but even more for small and medium sized enterprises which do not hold their intellectual stakes in software patents, but in the creative potential F/LOSS provides to them. With an increasing share in professional software production F/LOSS will be one of the fastest growing fields of employment in software industries in the upcoming decade. Furthermore F/LOSS is actually one of the few fields where information sharing and trans-national cooperation beyond the frontiers of EU member states is already in place and working. F/LOSS contributors are often highly mobile, flexible in their choice of working and living environment and continuously striving to increase their computer literacy. They can be considered as *the* workforce for the knowledge based economy.

Whereas the European Commission's ICT strategy over the last one and a half decades pointed towards regional cohesion and inclusion of users we argue here for a an inclusion strategy that not only focuses on users but also on producers of ICTs. When F/LOSS as a sustainable form of technology production becomes an important factor in Europe's economic environment it is important to integrate as many groups within European societies as possible, in particular women who are so strongly under-represented. We believe that at this moment it is crucial for the further development of F/LOSS and its stakeholders to begin to make use of a broader base of contributors, i.e. that the community starts to integrate a larger variety of the society in its

production process. Our survey, however, also showed that the European Union has a significantly lower ratio of female participants than all other regions worldwide (i.e. USA, Asia, Latin America, Africa). This should be particularly alarming for the European Commission which has an interest in keeping its competitive advantage in this field.

Because so many people begin their careers in software through early tinkering on computers, F/LOSS would benefit from improvements in gender inclusion in both ICT use and production generally. The public policy instruments available to address these wider questions have been identified by the EC-sponsored Strategies of Inclusion: Gender and Information Society programme, as well as other international efforts such as the Commission on Technology, Gender, and Teacher Education, convened by the American Association of University Women (AAUW). Specifically, we would encourage focussing on educational interventions, as formal education seems to be much more significant for women's decisions to become programmers than for men (Margolis and Fisher 2000).

Here we limit our recommendations to those that are specific to F/LOSS; however, it is important to emphasise policies specific to F/LOSS are most likely to be effective in a context where women and girls are likely to engage with ICTs more generally. As we showed in section 4.1, the 'digital divide' issue with respect to F/LOSS is not only an issue of getting women interested in computers at a young age (although that does play a role), but the wider conditions within technological professions.

F/LOSS communities show aspects of organisation that require creative solutions. Institutionally, F/LOSS takes place sometimes within higher education contexts, sometimes within commercial contexts, and sometimes through groups of 'amateur' enthusiasts who self-organise through electronic communication and occasional face to face meetings. Self-organisation is very much at the heart of the F/LOSS community building, and much of the work is voluntary. Therefore the usual repertoire of recruitment and retention techniques deployed in large public or private sector organisations (such as quotas and flexible working), needs to be supplemented and adapted. This will require both creativity as well as resources. As section 4.6

shows, women are particularly disadvantaged by the reliance on unpaid labour. Again, here different policy spheres interrelate. Women are also disadvantaged in getting access to venture capital such as private equity financing (Amatucci and Sohl 2004). Although it is outside the scope of our remit, policies to address this inequity we believe would help make it possible for more women to become involved with F/LOSS.

Our recommendations are proposed on the principle that policy should explicitly aim to work with the community's values and social dynamics rather than impose its own. Public policy risks becoming irrelevant tick boxes and arbitrary bums on seats numbers if this fails to be the case. The SIGIS report (2004) stated four reasons why women should be encouraged into ICT professions:

- The justice argument points to the fact that women may be deprived of an opportunity to contribute to and influence a growing and important technology in all parts of the society.
- The equal opportunity argument points to women's rights to the benefits offered by the ICT industry labour market.
- The resource argument refers to societal losses when the scientific and technological talents and experiences of women are not utilised.
- The labour market argument highlights women's potential role in contributing to the supply of computer science educated labour to the industry (p 60.)

These reasons, however valid in researchers' or policymakers' eyes, are constantly challenged and critiqued by both men and women in ICT professions. This criticism needs to be understood and taken into account. The European Commission could very well have social justice and equality of opportunity as part of its goals, but to highlight these goals as part of policy action may in fact invite its own irrelevance to F/LOSS, which as we have demonstrated, believes itself already working for equality and social justice through meritocratic organisation. Anything that connotes special help based on gender is likely to undermine rather than assist. The EC and other public policy bodies would do well to recognise that the mere mention of gender

raises in many peoples' minds a set of problems that, as individuals, they feel they are not a part of, and for which imagined remedies constitute a threat to meritocracy.

This is not to say that we are calling for an introduction of 'gender-blind' initiatives. Gender blindness is a fallacy which many scholars argue codes one set of gendered practices as normal, rendering other practices deviant or irrelevant (Wajcman 1991, Gill and Grint 1995, Faulkner et al 2004). Instead we argue that the more effective course is to design public actions with gender in mind, but based on the needs of the community and in a language that the community will read as legitimate. The goals of *rectifying the loss of a talented labour pool and with it the opportunity to build better technologies* is something that is already recognised as a problem within F/LOSS communities, and is far more likely to motivate action than social justice concerns. Therefore, we would recommend that these concerns be highlighted as the rationale for initiatives. We realise, too, that this approach, similarly endorsed by SIGIS, has been deemed 'perplexing [and] requiring alternative interpretations' by another scholar (Lin 2005) because it effectively prioritises women's economic contribution over social justice. However, our goal is to propose plausible pathways for change. These need agreement from the community.

F/LOSS still is very much based upon voluntary work which people carry out in their spare time rather than as part of their paid labour. Therefore a lot of measures which are successfully applied in the work environments of companies, public sector institutions or others can not be employed in this context. This particularly concerns issues of discrimination, inflammatory talk, valuation of particular work tasks and so forth. Activities tackling these issues have to come from inside the community itself and we would rather not propose recommendations in this directions. It is up to the community as a whole to decide upon how it should organise itself and communicate this. It is up to single projects themselves to integrate measures such as rules of conduct or other forms of tackling the social dynamics set out above. On the other hand it is up to the European Commission to support activities and initiatives which aim to foster the role of women in F/LOSS and which help to increase female participation.

6.2 Specific Proposed Actions

We believe that mainly changes within the F/LOSS community itself can lead to both more women taking part in F/LOSS as well as to a shift in the way they contribute. Nevertheless there are possible ways public sector institutions can support such change. These recommendations have been developed for the European Commission, however many of them can be carried also by other public sector institutions on different administrative levels:

European Commission: all recommendations
Local authorities: 6.2.1. - 6.2.5, 6.2.8.
Regional authorities: 6.2.1. - 6.2.6., 6.2.8.
National governments: 6.2.1 - 6.2.8

6.2.1 *Provide tangible resources to help women devote time to their F/LOSS activities. This means both funding helping women to take part at specific F/LOSS events, as well as continuous support to enable women to take part in F/LOSS projects over a longer period of time..*

One major reason that women do not participate in F/LOSS is that it is largely produced in developers' spare time (see section 4.6). The survey results suggest that women in the community spend an extensive amount of their leisure time contributing to F/LOSS, too. However it is very likely that this is one of the barriers for women who do not have such an amount of spare time to spend on F/LOSS due to responsibilities related to household work and childcare. It is therefore crucial to provide tangible resources in form of facilities that enable women to devote time to F/LOSS. On the one hand this concerns events taking place offline, in particular F/LOSS conferences, hackathons, install parties and so forth. Funds would be necessary for organisers of such events to provide childcare facilities. Projects could include larger European conferences such as the FOSDEM (Brussels) or Linuxtag

(Karlsruhe).

In addition, facilities are needed to help women in their continuous participation within F/LOSS projects on a more regular basis. It is important that F/LOSS contributors can devote several hours in a row on a weekly basis for their F/LOSS activities. Women often do not find the opportunities for this continuous time at home and therefore require a dedicated place to achieve their tasks. As it would require a large effort to create these facilities *specifically* for female participants of F/LOSS, it would be more efficient to link to already existing facilities in public institutions (such as universities) which are already familiar with problems women face in computing, and have in place solutions which give opportunities to women. The Computer Laboratory at the University of Cambridge, for instance, provides computing facilities with attached childcare to their students and staff. These institutions are already in place and have proven their effectiveness. Special agreements could be negotiated so that women who aim to participate in F/LOSS projects can make use of these resources. The ubiquity of higher and futher educational institutions throughout member states provides the opportunity to make a genuinely local and accessible solution available to a large number of women, building on infrastructure that is already in place. Funding would certainly be required as well as the establishment and co-ordination of the programme. This would have to include coordination on the local level to link these programmes to current or potential F/LOSS participants. Collaboration with local womens' advocacy groups provides an immediate avenue. In addition to universities we recommend a link to other institutions that foster the reintegration of women into the workforce (e.g. via adult education). A vital aspect of the above proposal is to put F/LOSS on the political agenda of educative measures (see also below).

6.2.2. Foster the participation of girls in F/LOSS activities at an early age.

Our research has shown that women in F/LOSS start both their computing activities as well as their contributions to F/LOSS in a later phase of their life (section 4.1 and 4.6). This causes some of the problems in their F/LOSS participation since they have

to undertake a lot of ‘catch up’ work before they are able to contribute to much of the development activities (section 4.4) . It is therefore important to support activities that encourage girls to get into F/LOSS at a similar age as their male counterparts. This can be achieved though a variety of means.

Contribution to F/LOSS projects normally starts out with the installation and use of the software itself. Therefore the European Commission should support schools specifically in teaching computer skills with F/LOSS products rather than proprietary software (e.g. using OpenOffice rather than Microsoft Office suites, programming in Python rather than in Visual Basic). Formal education in computing seems to be particularly relevant for girls and therefore it would be helpful to integrate F/LOSS technologies already in school computing syllabi.

Furthermore many of our female participants reported the helpfulness of an all-girl environment during their first phase of getting into computing and programming (e.g. schools, workshops, mailing lists). Whereas we do acknowledge that this might not be necessary for all potential female F/LOSS contributors it is important to understand that this is very effective for some. Therefore we consider short term interventions such as holiday camps with F/LOSS technologies for young girls interested computing as a way of minimising knowledge gaps and the resulting confidence problems, as these have proved to be a stumbling block in the later integration of women in F/LOSS communities. We feel that this would be best carried out in collaboration with already existing and experienced initiatives in that field (e.g. grepgrrls).

Despite the fact that a lot of activities related to F/LOSS take place online via email, IRC and other forms of remote communication, offline events are crucial for the feeling of being integrated within the community. On the one hand local events such as LUG meetings and install parties are important, but on a project level workshops and conferences play a far larger role. There seem to be less difficulties for boys taking part in these events, and they do so at a younger age than girls. Girls in their teenage years seem to be almost wholly absent at such conferences. It would be helpful to provide measures to enable women in this young age to go to relevant

conferences. Grants should include direct funding for transport, but in some cases also special arrangements for accommodation. Support should not be directed only to girls giving presentations, but also to girls who want to take part to gather knowledge about FLOSS.

6.2.3 *Provide support for the efforts to increase female participation that are already taking place within F/LOSS.*

There are a number of groups, such as GNOME Women, Debian Women, Apache Women, Grepgrrls and LinuxChix that work to support women in F/LOSS. Whilst they are significantly different in their approach and philosophies, they could benefit from the same sorts of material support. This would include:

- Sponsorship for women to attend the main F/LOSS conferences
- Support for women's networking events
- Material resources (webspace, printing material, travel costs) to publicise and promote female engagement in F/LOSS communities (e.g. at the school, public technology fares, etc.).

The latter activity is particularly significant, as men tend to be made aware of F/LOSS much earlier than women through informal networks in which women often do not participate.

6.2.4 *The European Commission, and EU Governments should use their commissioning role to encourage a greater variety of working methods in the production of software.*

F/LOSS communities tend to value writing code at the expense of other forms of work that go into producing software (see section 4.3). This can include (but is not limited to) documentation, user interface design, user requirements capture, community organisation, and software popularisation/marketing. Indeed, both men and women can be found doing these 'other' roles, but women are in practice more

likely to be involved in these functions (see section 4.1), just as they are in proprietary software. If the EC were to encourage expanding and changing these roles it would be critical to have equal say in the final product, otherwise there is a danger of merely re-articulating stereotypes and expanding a continued marginalised presence.

Nevertheless, if projects were to actively seek more diverse participation, not in terms of personal identities but in terms of the processes by which software can be built, a broader range of talents and aptitudes could be recruited into the movement. This has the potential to destabilise gender practices by encouraging dialogue and learning opportunities. User-centred design, for example, both makes a more robust, usable product and sets new intellectual challenges for coders. In the space shuttle example documented in the Appendix to this report, documentation leads software design rather than coding. By encouraging dialogue, both of these disrupt the sharp distinction often made between technical leadership and social/managerial leadership.

The success of encouraging this sort of diversity depends almost entirely on its execution. The emphasis should be on destabilising and innovating rather than making F/LOSS ‘less technical’ (the space shuttle example also demonstrates this well). A situation where people felt that their ‘hacker’ identities, and the individualist flourish that comes with it, was under threat would be counter-productive. Similarly, some women expressed to us concerns about being ‘reduced to’ diplomatic roles and this is in fact a danger. Successful implementation would treat new organisational forms as a continuation of the way in which F/LOSS already sees itself as significant and creative innovators in ways of producing and distributing software, and already values a ‘thousand flowers blooming’, as members are fond of saying. There are, for example, more or less ‘off the shelf’ techniques for organising software production such as agile computing and extreme programming which address these issues without compelling developers to commit to a rigid blueprint. These alternative forms of software production all have in common that they emphasise the fact that programming is a social activity. Further information about these methods can be found in the Appendix. All of these experiences and practices could be adapted and selected to meet particular project needs.

The EC has a range of mechanisms at its disposal to do encourage these innovations. It could, for example:

- Strengthen the development methods criteria in evaluating software proposals and actively seek methods beyond ‘code and fix’ that worked to prevent quick but buggy releases from being produced.
- Support proposals which identify innovative methods and provide advice on the successful implementation of them. For example, in our experience, user-centred design can often be a matter of lip service rather than actual practice.
- Provide training in usability, participatory design, and documentation methods.
- Expand funding for projects explicitly aimed at pioneering software development methodologies, and promote the results.

Using the EC’s own commissioning practices would solve the objection that ‘we don’t have the resources’ that is often used to justify the way documentation and usability is treated as an afterthought. It would also enable F/LOSS communities to recognise these skills as acquired rather than innate (and gendered) capacities.

Further information about software development methodologies can be found in the Appendix.

6.2.5 *Modify the criteria for the selection of software products supported by the European Commission to ensure encouragement is given to those who positively include women in technical roles or offer other means of support for encouraging girls and women to enter computing.*

EC's funding practice is often very output oriented. Research proposals are evaluated mainly by the outcome of a proposed project rather than by the way this outcome is achieved. The project's consortium is evaluated on an institutional level and questions

of diversity of the team working on it are often not taken into account. In terms of F/LOSS development we argue that the team producing software significantly determines its end result. The European Commission could foster diversity in the production of commissioned F/LOSS products by making proposers aware of this need for diversity. Matching funding could be provided preferably to research projects producing F/LOSS when the consortium´s partners have already or will hire female developers in key roles.

6.2.6 Sponsor exchange programs or joint projects with parts of the world where coding is not axiomatically gendered as a 'male' activity.

While there is at least some agreement that sexist practices happen, many people are convinced that these involve 'other' men and therefore have nothing to do with their own behaviour. Significant change will only occur when individual members of the community recognise their own actions as counter-productive. Indeed, the 'HOWTO Encourage Women in Linux' article goes a long way towards helping its readers recognise potentially unwelcoming behaviour. Another way to break down this perception is by facilitating direct encounters with people who interrupt taken-for-granted categories—that is, put people in situations that take them out of their comfort zone and require them to reflect on how they interact with others. This technique has been used successfully to combat racism in a well-known UK school[6]. In some parts of the world such as Malaysia, computer science programmes have half female students (Ng 1999), and it is considered a job 'suitable' for women (Berg Lagesen 2002). Indeed our survey showed for F/LOSS that in non-western countries the share of women is twice as high as in Europe and the USA.

Researchers sometimes talk about the importance of making these cases visible in order to unsettle gender dualities (Lie 2003), but this is unlikely to reach developers in any meaningful way. Facilitated face-to-face contact would do much more to alleviate the 'it's not me' problem. Although the particulars of such international

[6] See http://www.standards.dfes.gov.uk/studysupport/casestudies/georgegreens for more information.

contact would have to be tailored to particular projects, facilitating these contacts would have the added benefit of encouraging technological transfer into the European Union and directly support its competitiveness. The German government already experimented successfully with commissioning an exchange programs between the KMail project and collaborators of the PGP encryption technology in another context.

6.2.7 *Create a greater understanding, through research and dissemination of projects where technological success was achieved because of diversity.*

Women's activists within F/LOSS have already started making the case that more diversity is likely to lead to better technologies. They are frequently asked "what kind of better technologies?" The EC could help raise awareness about the answer to this question. There is debate within F/LOSS circles about whether programmes should be made user friendly, and this debate takes place in gendered terms (see section 4.3). However, within the community it is nearly impossible to question the value of stable, error-free software. There are in fact case studies and examples where changes in development practices went hand in hand with the inclusion of women, which in turn mean 'better' software (see Appendix for specific case studies).

Examples like these:

- demonstrate in no uncertain terms the value of thinking outside the hacker box, and the gains for software when women-friendly working practices are adopted
- demonstrate that 'social' concerns are technical concerns and make better end products
- help women developers feel less isolated and anomalous
- make women more visible to men in a context where they are often assumed to be invisible

In this context it would also be helpful to raise the profile of already existing women in F/LOSS projects and their different forms of contribution. Initiatives such as publishing interviews with female contributors to the KDE project, for instance,

helped to make them more known within the community as well as outside the KDE project itself. Encouraging project leaders to communicate about existing women who are in their project to online media that are read by a larger F/LOSS public (e.g. via forwarding contact details for interviews) would both make women more visible in the F/LOSS universe as well as would underline the efforts of the particular project to be welcoming to women.

6.2.8 Encourage individuals in leadership positions to recognise that people are being actively put off, not just failing to choose to participate, and that this has a long term cost to F/LOSS development.

F/LOSS puts a great deal of emphasis on charismatic leadership. These leaders therefore also must bear some of the responsibility for the culture they have helped create and shape. Sometimes male members do vocally support women in their attempts to counter sexist talk and the constant stream of sexual attention, either by becoming involved in online exchanges or helping to explain to other men appropriate ways to react to women's presence. With so few women this support is necessary, as lone voices are easily dismissed as over-sensitive or censorious. Such support, however, would be far more credible and effective if it were to come from well-known people in leadership roles. Discourse about gender focuses far too much on female disinterest, often legitimating sexist and inflammatory talk as just part of 'banter'. There are also discourses about the hostility that too often greets F/LOSS women, but the leadership could use their pulpit power to help the community recognise the cost of this 'banter' in terms of labour and potential software improvements. Currently, much of the leadership is unaware that there is a serious problem, and the discussion about the ways in which the cultural tone they contributed to affects women has not yet taken place. We suspect that the 'gender is nothing to do with my personal actions' problem sometimes extends to the leadership as well. This is an immensely challenging issue, as it is likely to raise hackles and accusations of divisiveness. Nevertheless, we feel that any lasting solution must have the support of those in leadership roles.

Again, the notion that talk should be monitored or regulated is easily de-legitimised as 'political correctness'. We feel that a plausible course of action is not to attempt to silence people, but for the leadership to make them aware of the cost they are incurring on the long-term success of F/LOSS. The articles that already exist on the subject indeed take this tactic.

It is well worth noting too that it is not just women being put off. For instance we found anecdotal evidence that suggests, participants from countries where adversarial talk is frowned upon also leave the movement quite rapidly.

6.2.9 *Foster a greater role for F/LOSS in European innovation policy, and specifically in university technology transfer activities.*

Women are particularly disadvantaged by the lack of resources externally available for F/LOSS development, as they are least likely to have 'spare time' to devote to it. One way to secure women's involvement is by increasing the public sector resources devoted to its development. However, technology transfer activities for universities tend to centre on patenting and licensing exclusive rights. When projects are made F/LOSS in universities it is through decisions by individual researchers largely in the absence of institutional support. In the UK, for instance, there is a funding stream specifically for economic development activities, which has widened the scope of technology transfer activities. Even in these conditions F/LOSS software development rarely features. Yet there are plenty of unexploited opportunities for mutual gain in combining F/LOSS models with university 'third stream' activities (Willinsky 2005).

Putting F/LOSS on the technology transfer agenda would provide opportunities for highly educated women to participate as part of paid, stable employment. Through their advanced skills they are also likely to be in an advantaged position to take leadership roles and serve as visible role models. There are further benefits as well. Including F/LOSS as part of technology transfer activities would also help diffuse the fiercely dichotomised and entrenched debate about what some call the privatisation of universities, and therefore help to secure better co-operation and support for

university commercial activities amongst faculty members and researchers.

What counts for universities should also be applied to other institutions – private or public – which use tax revenue such as research and development grants commissioned by the EC or national governments. It should be mandatory for publicly funded software to show the necessity to restrict public access to the outcome of their work by not issuing it under a F/LOSS license. This measure actually would not require extra funding or organisation though it would have a huge impact on both Europe's leading role in the field of F/LOSS as well as on the likelihood to increase female participation in F/LOSS.

6.3 Concluding Remarks

Supporting gender equity in F/LOSS is not a regrettable cost that must be met in the interest of social justice. Rather, there are plenty of additional 'wins' to be gained, not just for F/LOSS but for the EU's competitiveness as a whole. As an industry, F/LOSS is in its growth stage. Just as software development efforts are still very much about 'just making it work', so too are the relationships and social arrangements at stake in its production. There is what Ratto (2003) calls the 'pressure of openness' which makes F/LOSS both an unstable and innovative way to produce software. *How* software is produced has just as much social impact as the technologies themselves. Now that F/LOSS is maturing and generating so much interest from unlikely sources, it is the time to realise the gains that gender equity brings.

7. Recent changes and significant developments for gender issues in F/LOSS

During the term of the project there have been significant developments in the realm of F/LOSS production. These developments might amount to the emergence of what we could call a ‘post-avantgarde’ phase of F/LOSS.

Up until end of the 1990s F/LOSS was a mainly non-commercial endeavour. As one of our informants told us: “When I got into the project in 1996 nobody believed that we would have such a success and that so many people would use it. Of course we wanted it to become successful, but I worked on it just for fun.” Despite the early success of projects like the Linux distribution Redhat or the webserver Apache there were still few large software companies involved in F/LOSS at the turn of the century. The situation is currently undergoing change. On the one hand there are more and more companies that employ F/LOSS for their own usage or their follow-up products (Google, Yahoo, Apple, etc.). On the other hand companies take F/LOSS products for building and selling complete solutions (IBM, HP, etc.). These companies have a genuine interest in the further development of these F/LOSS projects and are willing to contribute to them through their employees time. Furthermore there are more and more companies which either lead the development of large F/LOSS projects (SUN, Ximian, etc.) or develop open source software completely on their own (MySQL, Trolltec). Profit strategies and business plans have been explored and reach from servicing to dual licensing. What is important in our context is that F/LOSS is evolving from an underground ‘avantgarde’ kind of movement to a widely accepted and possibly soon-to-become ‘mainstream’ industry. It is no longer only some computer programmers who understand the production model and licensing particularities of F/LOSS but also people in corporate business who take an interest in the movement.

Furthermore development tools themselves are more and more developed in F/LOSS. On the one hand we thereby think of programming languages such as Python, Ruby or Mono which are profoundly located in a F/LOSS context. On the other hand libraries

such as the GTK or QT become significantly more important and are used by smaller and medium sized companies.

Finally hardware producers which used to either produce software for a very particular kind of platform or for large platforms (i.e. Windows or Mac) start to show more interest in making their hardware work on F/LOSS platforms (e.g. Linux or BSD) and thereby contribute to these platforms. A long term contributor to the Linux kernel project for instance has confirmed this development: Recently hardware producers are more interested in their components running on the Linux kernel. They make driver development a part of some employees job description and thus collaborate in the Linux project.

Some participants regret this commercialisation of F/LOSS and report a change in the culture of F/LOSS. As a consequence of this development professionalisation starts to play out in different aspects relevant to the question of gender. Whereas volunteers do not have to take into account rules of courtesy, corporate rules of communication are strictly limiting offensive behaviour. This automatically limits the frequency and intensity of flame wars (see 4.6) as well as makes it less acceptable to show sexual attention towards women (see 4.5). People in a corporate setting tend less to identify with the hacker ethos (see 4.2). Furthermore – similar to earlier proprietary software development – the production of a whole product becomes more important than the sole development of code. This forces coders more to collaborate in tasks like documentation which will increase the value of these tasks. Also there are more jobs available which will decrease the necessity for voluntary work which – as we have seen – may be particularly difficult for women (4.6).

A similar development is recognisable in public sector institutions. F/LOSS is increasingly employed in public organisations. While migration of existing F/LOSS projects is certainly the most significant engagement of public bodies at this stage we can observe that development requirements and practises are increasingly fostering the production of new collaborative software projects using open source methods and licenses. Additionally to increased demands in terms of documentation and usability (which is also the case in the private sector) public bodies require a high level of

accessibility which has already lead to an increasing involvement of corporate engagement in the GNOME accessibility project (see e.g. the involvement of Sun Microsystems in the Gnopericus project).

While the F/LOSS movement, up until very recently, was occupied with the production of tools used by other programmers (such as text editors, libraries, kernels, drivers, etc.) some projects have reached a maturity level where the targeted users are people that are no longer more than average computer literate. Projects such as the web browser Mozilla Firefox have a market share of currently about 20 %. Word processors such as the OpenOffice Writer are increasingly replacing proprietary products. Desktops such as GNOME or KDE are on the verge of becoming mainstream. Whereas F/LOSS developers used to code for other programmers or professional system administrators who appreciate a maximum amount of configurability at the cost of usability, the success of F/LOSS products aiming for a large, non-computer literate public is measured the other way round. With an increasing non-programming user base the requirements for F/LOSS software change. Consistency, usability, interface design, documentation and support become significantly more relevant.

One can observe a stronger role of so-called developing countries in both the general computing industries as well as in the F/LOSS movement. The development of software is carried out more and more in countries such as India, Brazil, South Africa, Russia, China or others. Large corporations move not only the production of lesser qualified programming and servicing tasks into these countries, but also build up research and development centres there (see e.g. Google´s establishment of their R&D department in Bangalore).

Interestingly women seem to be far stronger represented in these countries. In our survey the share of women in developing countries[7] compared to men was about 16 % whereas in ´first world´ countries the share of women was only half that high (8

[7] We divided the sample in two groups one consisting of EU member states and candidates, EFTA, USA, Canada, New Zealand and Australia, the second consisting of all other countries.

%).[8] Again we suspect that the commercial software industry plays the main role.

Whereas this commercialisation will certainly contribute to raising the numbers of women in F/LOSS production it seems likely also that there will always be F/LOSS projects that continue to recruit their collaborators from volunteers. It is here that our recommendations will perhaps have most purchase, although commercial organisations who engage and produce F/LOSS code (and indeed code in general) would also usefully take these findings and suggestions into account.

[8] The overall ratio of women is by far higher than in earlier survey (e.g. Ghosh et al. 2002, Robles et al 2001). Even though we do assume an increase of women in F/LOSS it is difficult to measure since the survey was predominantly targeted to gender issues which certainly motivates more women to take part in it.

8. Appendices

8.1 Glossary of Terms

Please note that this glossary is a glossary of working definitions intended to enhance the readability of this document. As these terms are sometimes contested and controversial, this glossary does not reflect a set of official definitions.

Apache: a webserver project produced and organised by the contributors Apache Software Foundation

Bugs/de-bugging: Flaws in the way the code runs. In any programme there is a large number of potential pathways through the code, to achieve different ends (blue text not red text combined with this font not that font etc.). The more people that use the code, the more chances all these paths are followed, and flaws in the flow are discovered and fixed.

Debian: a widely used community based, non-commercial Linux distribution created by an equally large number of participants. Debian is one of the oldest and largest free software projects.

F/LOSS: Free/Libre and Open Source Software. Overall term which encompasses the various groupings and allegiances all based upon free or open source software licenses.

Free Software: term of choice for many F/LOSS participants referring to the freedoms to use, examine, modify and distribute the software. The term was invented by he founder of the GNU project, Richard Stallman.

GNOME: One of the largest free desktop environments.

GNU: Stands for ‘GNU's Not UNIX’. It is a project which aims to create a completely free Unix operating system.

GPL: General Public Licence. Based on each authors’ copyright in their material, a license which provides free software, but enforces obligations license any modifications of code under the same condition (copyleft).

GUI: Graphical user interface.

Hacker: a programmer/person intensively interested and engaged in the analysis and production of software. NOT someone who makes illegal attempts to crack into computer system.

IRC: Internet Relay Chat is synchronous form of communication. It takes place on different networks and IRC channels are set up to discuss a particular topic, software, platform or others.

KDE: One of the largest free desktop environments.

Linux: GPL licensed kernel as an integral part of an operating system (such as e.g. the

GNU operating system). The project was started and is lead by Linus Torvalds.

Open Source: Marketing term coined by Eric Raymond. The term is often employed by commercial producers of F/LOSS and aims to emphasise the development practises rather than the aspects of freedom of F/LOSS.

Source code: Human-readable set of instructions which later is compiled to binaries. In most proprietary software, only the computer executable form is made available to the user.

Unix: one of the earliest proprietary operating system. Blueprint for the late GNU project.

8.2 Case Studies of Diversity Contributing to Successful Technology Development

8.2.1 Lockheed Martin Space Shuttle Group

This is a highly prestigious example from the field of proprietary software that easily demonstrates the importance of diversity for good software. This group builds arguably one of the most reliable software in the world, which controls everything NASA's space shuttle does from launch until landing. Ten out of twenty-two members of the group are women, many of whom are in senior technical roles.

The reason the software is so error-free is the attention given to process and design. The code was successful precisely because they changed the relative value placed on writing code. In contrast to the dominant 'hacker' model, specifications are precise and teamwork is valued over individual inspiration. The creativity is in writing the specification and improving the process. In this way the supposedly 'soft' skills are re-evaluated as 'technical' and are not marginalised. Also, the group works ordinary workdays and does not stay up all hours of the night, which has particular advantages for women with family commitments. While there are important differences between this highly elite group and an average F/LOSS project, equally there are valuable principles that could be adopted and adapted.

For further information, see:

http://www.fastcompany.com/online/06/writestuff.html

http://www.lockheedmartin.com/wms/findPage.do?dsp=fec&ci=13183&sc=400

8.2.2 Carnegie Mellon University School of Computer Science

Carnegie Mellon has one of the most prestigious departments of computer science globally and has made a serious and successful effort to recruit women. Over the past five years they have changed their female admission rate from 5% to 42%. A central element of their success is the recognition that previous programming experience does

not predict eventual computer science success, and they stopped using prior experience with computers as admissions criteria. They have devised a flexible first year programme that takes account of various levels of experience. The continued quality of the programme demonstrates that being 'newbie-friendly' does not come at the expense of setting interesting programming challenges.

For further information, see: Margolis, J and A. Fisher, (2002). *Unlocking the Clubhouse: Women in Computing.* Cambridge, MA: MIT Press.

8.3.3 Open Usability Project

The Open Usability Project matches usability experts with free software projects, thus building more diverse teams of people working on Free Software projects. While its contributors faced at the beginning a somewhat critical response by KDE developers its role now is widely accepted in the production of this Linux desktop project. It is one of the projects in which usability is understood as a technical competence and its contributions (often by female participants) are not perceived as an afterthought.

For further information, see http://www.openusability.org/.

8.2.4 Xerox Parc

Lucy Suchman (1999) reports on a change in the relationship between technology designers and social scientists and usability specialists at Xerox Parc. Industrial research traditionally has been modelled as a disciplinary assembly line, where work is passed off to the next specialist in a queue. There has been a long standing mutual dissatisfaction in failure of technologies and ideas to 'transfer' from one to the other: one side 'fails' to take advantage of knowledge about users, the other 'fails' to address the needs of development, each rejecting the assumptions that created the demands for knowledge. At Xerox Parc this assembly line model has been replaced with mutual learning, and acknowledging partial translations and person's limited sphere of knowing and acting. In acknowledging that technology production is an extended field of alliances and contests, the 'divide' amongst different skills set is diffused, and people are better able to acknowledge the responsibility that comes with inhabiting a particular position.

With this shift in their own work practices they were better able to solve consultancy problems. For example, in work for a law firm they tried to engage users as collaborators in technology production, recognising the mutuality and overlapping nature of their work; not the 'assembly line' model. Attorneys described litigation support as monkey work, target for automation and outsourcing, but found these 'document analysts' had to carefully examine and encode thousands of documents, had to create a valid and useful database, could do some of junior attorney's tasks. The attorneys underused the database due to their ignorance of its capabilities. Wanted to design something that would relieve the tedium, but help them maintain interactive control and judgement, thus 'inscribing' users' value into the technology.

For further information, see:
Suchman, L. (1999) “Working relations of technology production and use” in D. MacKenzie and J. Wajcman, *The Social Shaping of Technology (2nd edition).* Buckingham: Open Uinversity Press.

8.2.5 Ubuntu

Ubuntu is one of the most recent Linux distributions. It describes itself as “Linux for human beings”. It quite explicitly values diversity both in terms of social identities and the various skill sets that make software production and use possible.

It is one of the distributions that particularly allocates resources to tasks which otherwise are seen as afterthoughts such as documentation, translation, etc. The success in terms of usability is tremendous. Within less than two years it became one of the mostly used Linux distributions among private users.

For further information, see:

http://www.ubuntu.com/community/participate

8.3 Further Resources for Software Development Methodologies

Online Resources:

- Agile Alliance: http://www.agilealliance.org/programs/roadmaps/Roadmap/index.htm
- Case study of agile principles adapted to live programming situations:
- http://www.oss-watch.ac.uk/events/2005-07-04/extreme.pdf
- A description and history of various development methodologies: http://www.martinfowler.com/articles/newMethodology.html
- A consideration of F/LOSS in relation to traditional development methodologies: http://www.ics.uci.edu/%7Ewscacchi/Papers/New/Scacchi-BookChapter.pdf

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