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Author(s): Ulf Mellström
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ABSTRACT   This paper reports an investigation on how and why computer science in Malaysia is dominated by women. Inspired by recent critical interventions in gender and technology studies, the paper aims to open up more culturally situated analyses of the gendering of technology or the technology of gendering, with the Malaysian case exemplifying the core of the argument. The paper argues along four different strands of critical thought: (1) a critique of the analytical asymmetry in the process of co-production in gender and technology studies; (2) a critique of a western bias in gender and technology studies, advocating more context sensitivity and focus on the cultural embeddedness of gender and technology relations; (3) a critique that pays more attention to spatial practices and body politics in regard to race, class and gender in relation to technology; and (4) a critique of 'western' positional notions of gender configurations that opens up for more fluid constructions of gender identity, including the many crossovers between relational and positional definitions of femininity and masculinity.

Keywords   body politics, computer science, gender, intersectional analysis, race

The Intersection of Gender, Race and Cultural Boundaries, or Why is Computer Science in Malaysia Dominated by Women?

Ulf Mellström

This paper addresses a familiar concern about the inclusion of women in science and engineering. Women's participation in science and engineering varies greatly around the globe, but there still seems to exist, as Lagesen (2005: 19) states, a lingering notion of an all-encompassing masculine culture of science and engineering transcending time and space. By using empirical data from Malaysia in the context of computer science, the paper aims to open a culturally situated analysis of the gendering of technology that undermines any notion of a global masculine culture of science and engineering, transcending cultural and national differences. Inspired by recent critical interventions and new analytical openings in gender and technology studies (Lagesen, 2005, 2007a,b; Bray, 2007; Landström, 2007; Rommes, 2007) the paper points to a western bias of gender and technology studies, and argues for cross-cultural work and intersectional understandings including race, class, age and sexuality. With the Malaysian case

exemplifying the core of the argument, I argue that gender and technology studies needs to investigate configurations of masculinity and femininity in a cross-cultural perspective more thoroughly. The paper will focus on the relational dependence of male and female categorizations in gender relations, emphasizing that gender and technology relations are always deeply embedded in cultural contexts shaping the use, design and production of technologies and their co-production of gender and technology. In this it draws on earlier closely related work (Lagesen, 2005, 2007b), but it also differs in its aim to empirically analyse specific aspects of Malaysian culture, society and history in order to illustrate the cultural embeddedness of gender and technology relations. However, I shall use the Malaysian situation within computer science mainly as an example to highlight how an intersectional analysis takes form. Consequently, I shall not provide a full-fledged critical analysis of the multifaceted and divergent power dimensions of the Malaysian society.

The paper has three substantive parts. I will first present the so called 'woman problem' (Lagesen, 2005) in gender and technology studies and contemporary critical thought in feminist technology studies, invoking the theoretical tenets that possibly succeed this critique and how this feeds into the Malaysian situation. Second, I will present my case in terms of materials, methods, and the cultural specificities of computer science in Malaysia. Third, a discussion of the empirical case follows where I argue that the gender relations of computer in Malaysia has to be understood in regard to five strands of intersecting explanations: (1) quotas, ethnicity and gender; (2) a situated body politics; (3) techno-optimism and techno-nationalism; (4) under-achieving men; and (5) a critical mass of women and a shortage of computer professionals.

The 'Woman Problem' in Gender and Technology Studies

The so-called 'woman problem', meaning the exclusion of women in science and engineering, has been thoroughly investigated in gender and technology studies. In spite of the fact that women are becoming the majority of the student population in most academic settings around the world, the relative absence of women from science and engineering remains puzzling (Quinn, 2003; Lagesen, 2005). This is especially so for information technology (IT). This relative lack of women is seen as a problem, while a predominance of men is regarded as the norm (Kramer & Lehman, 1990). Learning environments are not friendly to women (Siann, 1997; Henwood, 2000). Computer science technology grew out of the military, and its aura of combat and war has never attracted women (Mörtberg, 1987; Edwards, 1990). In reviewing the literature, Lagesen concludes that the 'woman problem' in computer science mainly has been understood as an issue of exclusion, and little is known about the women who actually decide to study computer science (Lagesen, 2005, 2007a; Sørensen, 2002). The history of gender and computer science as well as IT in general seem to follow a well-known pattern in western history of technology. Throughout this history, men have

placed themselves in central positions, and technology has been associated with masculine values, whether it concerns machinery or digital technology (Cockburn, 1983, 1985; Hacker, 1989, 1990; Wajcman, 1991, 2000, 2004; Mellström, 1995, 2002, 2003, 2004; Oldenziel, 1999; Salminen-Karlsson, 1999; Faulkner, 2000, 2001; Lie, 2003).

In the western world, it seems that little has changed, as there are even fewer women in computer science today than in the late 1980s and the early 1990s (Salminen-Karlsson, 1999). However, when we look beyond the western world to developing countries such as Malaysia, we find that a growing number of studies present a more diversified picture (Kelkar et al., 2005; Ng & Mitter, 2005; Saloma-Akpedonu, 2005; Wajcman & Le, 2007). The position of women in the IT industry, and in new rapidly transforming digital economies in countries such as the Philippines, Brazil, Malaysia and Vietnam, gives hope for an emancipatory concern for a more gender-balanced division of labour. In an investigation in the Philippines, Saloma-Akpedonu (2005: 100) reports that women constitute 30% of the Philippine Computer Society and that their position in the IT industry has not resulted in a devaluation of status (see also Wajcman & Le, 2007: 6). In their study of the gender relations of software work in Vietnam, Wajcman and Le (2007: 23) conclude:

> Compared to women's employment in previous eras, IT work is a significant improvement. Women in the IT sector have higher levels of education and earn more than women working in agriculture or the service sector. The IT industry does provide a vehicle for women to gain both higher education and economic power in Vietnam.

The fact that in Malaysia, women's education, and their positions in computer science departments and software employment being equivalent to those of men, undoubtedly contributes to such relative optimism about gender and technology relations in developing countries. However, before moving to my case study, I shall briefly address some emergent epistemological dilemmas in gender and technology studies.

Analytical Openings in Gender and Technology Studies

Recently, critical interventions in the field of gender and technology studies have drawn attention to how heteronormative assumptions continue to pervade empirical research in feminist technology studies (Faulkner, 2001; Landström, 2007; Rommes, 2007). Landström (2007), in a critical re-reading of what she labels feminist constructivist technology studies, addresses the divide between theoretical discourse that collapses old deterministic gender binaries and empirical research that relapses into such binaries. In a similar vein, Els Rommes (2007: 13) shows how heterosexual imaginaries consistently work to reproduce gender dichotomies and hierarchies associated with computers, and how technologically competent women become masculinized in terms of various dimensions of heteronormativity. Closely associated with Landström's and Rommes' queer-theoretical interpretations

are Vivian Lagesen's (2005, 2007a,b) and Francesca Bray's (2007) accounts of the 'black-boxing' of gender in gender and technology relations, where gender often is represented as stable while technology is treated as open to interpretative flexibility. Although Lagesen and Bray do not problematize the 'semiotics of heteronormativity' (Landström 2007: 14), they nevertheless point to a common analytical asymmetry in gender and technology studies (see also Gill & Grint, 1995; Landström, 2007). Another critique that has been addressed at various times in social studies of science and technology, as well as in feminist science and technology studies (MacKenzie & Wajcman 1999; Bray, 2007; Wajcman & Le, 2007), which now seems as pertinent as ever, is that there are so few studies of gender and technology relations in non-western societies. This new wave of critical thought in feminist technology studies, which originated from a combination of sexuality studies, material-semiotic and postcolonial approaches, points to a need to address a wider range of analytical themes in order to capture the inherent complexities and ambiguities of gender and technology relations.

My analysis follows up on this call to address non-western gender and technology relations. There are critical analytical consequences to such a focus. As Francesca Bray argues, 'in focusing so closely on the gender–technology nexus itself FTS [Feminist Technology Studies] sometimes neglects deeper-lying ideological dimensions within which any regime of truth concerning gender and technology must ultimately be understood' (Bray, 2007: 19). Consequently, furthering gender diversity in gender and technology studies opens up cross-cultural interventions, comparisons and intersectional understandings. A huge spectrum of variations in gender subjectivities in relation to artefacts and technology remains open to investigation, and its analysis can bring new perspectives to the field. This also implies that addressing the relative absence of gender and technology research on non-western contexts should introduce a wider range of cultural perspectives on the gender relations embedded in a diverse range of settings. Studies of gender and technology relations, and of technological change in general, consequently require attention as to how gender as well as class and race often instigate changes in the social and cultural balance in a nation such as Malaysia (see also Harding, 2006).

When reviewing existing literature in gender and technology studies, one conclusion seems to follow, which is that few studies go beyond treating gender and technology as analytical parameters, to include intersectional understandings of the gendering of technology. In other words, if, in theory, gender and technology are co-produced (Faulkner, 2000, 2001; Lagesen, 2005), so are ethnicity and technology, age and technology, sexuality and technology, and class and technology (see also MacKenzie & Wajcman, 1999: 25–26). Still, these latter dimensions of cross-cultural comparison and intersectional understanding are generally absent from STS research, and gender and technology studies particularly, with a few notable exceptions (for example, Traweek, 1988; Dyer, 1997; Verran, 1998, 1999; Traweek & Reid, 2000; Adams, 2002). My purpose in this paper is to

invoke cross-cultural comparisons and intersectional readings, in general, and in reference to Malaysia in particular.

Consequently, my gender analysis is grounded in an intersectional understanding (Crenshaw, 1991; Peletz, 1996; Young, 1997; Yuval-Davis, 1997; Collins, 1998), where issues of inclusion and exclusion, power and powerlessness are to be understood by an integrative analysis of gender, race, age, class and nation. As the Malaysian feminists Cecilia Ng and Carol Yong (1995: 178) argue, '… while new technology skills are being polarized by gender, it also evident that women are entering computer professions in both the developed and developing countries, leading to a class polarization within the female labour force itself'. It is therefore also important to look at the wider picture in which technology, labour relations and education are embedded. From their Malaysian horizon Ng and Yong (1995: 178) also argue that, '[s]ince society is based on hierarchy, and technology is a medium of power, one needs to understand how power is negotiated'. In a postcolonial and multiethnic society such as Malaysia this also becomes highly pertinent, because class and ethnic differentials often are as important as gender differentials.

The Malaysian Case

The Malaysian case is interesting for gender and technology studies because of the gender ratios in the computer science and IT sectors of Malaysian industry. For instance, women constituted 65% of the students at the School of Computer Science at Universiti Sains Malaysia (USM), and 66% of the students in Computer Science and Information Technology at the University of Malaya, during the academic year 2001–2002 (Lagesen, 2005). As early as 1990/1991, women comprised 51% of the total student intake in computer-related courses in tertiary institutions (Ng & Yong, 1995). Among masters degree and PhD students at USM, more than 50% were women, and of the ten professors in the department in 2003, seven were women. There also is a high percentage of women in the professional information and computing technology (ICT) sector. Although Malaysian labour force statistics are not broken down according to specific educational attainments, women comprise 44% of professionals and 38.9% of technicians and associate professionals (ICT and computer science professionals are normally grouped in these statistical categories; see appendix).

These gender distributions are noteworthy and very encouraging in terms of gender equality. They can be regarded as a possible catalyst for change in a developing country where substantial portions of the population currently are reworking their social and ethnic identities (Kahn & Loh, 1992; Gomes, 1994; Goh, 2002). However, according to Kahn and Loh (1992), this grand narrative of a specific Malaysian modernity must also be understood in terms of a fragmented society in which an emerging and substantial middle class is conspicuous. This emerging middle class is portrayed as the symbol and hope for moving beyond a tradition marked by sharp ethnic divides between the three major ethnic groups – Malays (58% of the

population), Chinese (27%) and Indians (7%). Various political measures
and programmes under the New Economic Policy (NEP) of 1971, and the
New Development Policy (NDP) of 1991, aim to strengthen the national
economy and unite the country's ethnic groups. Still, a number of socio-
economic divides remain between the ethnic groups. This national balancing
act associated with efforts to promote interracial harmony thus continues to
pervade contemporary Malaysian society. In this balancing act, Chinese and
Indian people have been marginalized, as non-Muslims, while the Malaysian
state has been promoting a 'national culture' based on indigenous Malay
culture, combined with a distinctly Islamic 'govermentalism' as a central fea-
ture (Nonini, 1998). 'Malayness' is usually identified in terms of language,
religion and royalty (*bahasa*, *agama*, *raja*), and excludes anything 'Chinese'
or 'Indian'. This balancing act is codified in the ethnic divisions and official
politics between indigenous Malays (*bumiputeras*, meaning sons of the soil),
and a number of other indigenous groups and *non-bumiputeras* (the Chinese
and Indians).

The emerging middle class, united by relative prosperity and technical
development, has the potential to be a powerful symbol and contravening
force in the shaky ethnic and racial balance of contemporary Malaysian
society. The supra-ethnic nationalist rhetorics and politics of the country
have almost become an obsession with modernity through technological
development. Technology in general and IT in particular hold highly posi-
tive connotations and are seen as major sources of individual and national
empowerment. Malaysia, as a post-colonial society, has a nationalist poli-
tics that is most conspicuously manifested in Vision 2020 (Mahatmir,
1991), a plan for becoming a fully developed country – a K-society (knowl-
edge society). This 'vision' is directed towards a 'common destiny' to be
realized through technology and modernization. In such efforts to build
and create a subjective sense of commitment, a 'common destiny' is crucial
for constructing nationhood rather than emphasizing a common past
(Yuval-Davis, 1997). The Malaysian State emphasizes this vision of
national development as an effective way to generate a collective sense of
belonging. Recurrent public campaigns such as the *Malaysia boleh* (Malaysia
can, is able) crusade in the late 1990s and the beginning of 2000s persist-
ently declare that a Pan-Malaysian identity (*Bangsa Melayu*, see Ariffin,
1993) is built through technology and development. This Pan-Malaysian
identity is very much defined as a national body and is seen as primarily
economic and technological, and looking towards the future (Williamson,
2002: 419). This new middle-class is sometimes described as the 'haves' in
contrast to the 'haves-not' in the current programme of development.
Access to a knowledge society and IT appears to be the dividing line
between the 'haves' and 'have-nots' (Ng & Yong, 1995).

The relationship between gender (here almost exclusively defined as
women) and technology in Malaysia has been investigated from different
perspectives (Ong, 1987; Ng & Munro-Kua, 1994; Ng & Yong, 1995;
Levidow, 1996; Ng & Mohamad, 1997; Ng & Thambiah, 1997; Ng, 1999;
Lagesen, 2005; Ng & Mitter, 2005). As noted above, rapid industrialization,

with an emphasis on IT and globalization are leading to class cleavages within the female labour force in Malaysia (Ng & Yong, 1995: 178). For instance, within the electronic components industry (semiconductors, disk drives, and so on) low-skilled technology employment is predominantly female and will probably remain so. But at the same time, leading female professionals within ICT-related businesses are occupying an impressively high proportion of executive positions (Ng & Yong, 1995: 178). These women are partaking in the formation of this imagined, as well real, formation of the new middle class that is supposedly leading the Malaysian nation into the future. Paradoxically, part of the explanation for why women have come to dominate computer science in Malaysia is due to the intensive ethnification of the Malaysian society and its consequences for higher education.

In sum, an important conclusion that can be drawn from research by feminists and other scholars studying the Malaysian context is that theories of gender identity should consider that ethnic and class inequalities often are as important as gender differentials. This means that we cannot focus on gender per se, but must also investigate the complex interrelationships of gender, class, age and ethnicity in a multi-ethnic society such as Malaysia. By taking my point of departure with an intersectional understanding of the highly complex multiethnic and stratified society of Malaysia, I shall explore how cultural dynamics influence and shape the construction of computer science as a woman-friendly technological field.

Materials and Methods

Material for this paper was collected through policy documents, newspaper articles, labour employment statistics and popular writings. It also draws upon a long-term study of gender in Malaysia that began in 1997 (Mellström, 2002, 2003, 2004). In 2003 and 2005, with the help of lecturers and professors at the Computer Science Department at Universiti Sains, Malaysia, in Penang, I conducted a questionnaire survey with 150 students in a computer science class.[1] I also completed ten interviews with students in the same class, and supplemented those data with periods of participant observation in lecture halls and on campus. I also had numerous informal conversations with lecturers, post-docs and professors at the department. Out of the 150 students, 111 (73%) were women and 39 (27%) were men. Of the women, 68 (45%) were Malay, 38 (25%) were Chinese, and five (3%) were Indian; of the men, 20 (13%) were Malay, 17 (11%) were Chinese, and two (<1%) were Indian. The students were taking a course in computer ethics, which might have meant that a disproportionally high number of women were taking the course, but according to lecturers from the department, the gender ratio was similar to that of most courses in the department.

The questionnaire focused on gender, ethnicity, family structure, educational choice and career plans. The ten interviews followed up on the themes laid out in the questionnaire, and enabled me to go into greater depth on the themes, and in a more reciprocal manner. I also attended computer science classes and talked to students in between lectures, at

lunches, and at various social gatherings. I used English as the main language for the interviews, but occasionally also Hokkien, which is the dominant Chinese dialect of the island of Penang on the north-west coast of Malaysia.[2] In addition to these multifaceted data, I was able to draw upon previous experience with working in Malaysia to gain insight into gender and computer science. In what follows, I propose that a web of overlapping themes explains why computer science in Malaysia is dominated by women. My intersectional analyses draws on a form of methodological eclecticism that uses both historical and discursive understandings of Malaysian society, as well as individual and ethnographic evidence. Combining such diverse sources of data and interpretation produces a form of intersectional analysis that draws together a complex web of historical circumstances, contemporary politics and mundane realities.

Quotas, Ethnicity and Gender

As noted earlier, the Malaysian nation is continuously balancing issues of interracial harmony and disruption as one of its fundamental socio-cultural dimensions. This tension is literally inscribed into this relatively new nation's history, present and future, not least in the division between *bumiputeras* and *non-bumiputeras*. This division, which sharply separated Chinese, Indians and Malays, was originally implemented by the British colonialists, but it was reinforced in the first period of self-government after independence in 1957. This reinforcement of ethnic politics eventually resulted in the racial riots and bloodshed of 13 May 1969, when nearly 200 people were killed. The memory of this traumatic event has still to be overcome, and has strong symbolic significance in today's politics, as it continually weighs against the Pan-Malaysian creation of *Bangsa Melayu*. Yet, after more than 30 years of economic progress and reform (associated with the NEP and NDP programmes), aimed at eliminating the identification of race with economic function, the inter-ethnic economic imbalance still prevails but is slowly being eased according to some analysts. The ethnic boundaries are, however, manifestly continuing in connection with the *bumiputera* policy through which Chinese and Indians are disfavoured on the grounds of race 'negative', while the *bumipetera's* (sons of the soil) special rights and privileges are inscribed in the Malaysian constitution. These rights and privileges for Malays and the Malay-related groups are inscribed in Articles 152 and 153 of the Constitution. The privileges range from quota protections in the fields of education, scholarship, employment, training, trade, business permits and so on. The *non-bumiputeras* sometimes refer to these privileges as *kulitification* (*kulit* is Malay for skin, race) in contrast to qualification. They were implemented under the NEP in 1971 and the New NDP in 1991. The special privileges defined in Article 153 of the Constitution are a highly sensitive issue. For example, in December 2000, a number of Chinese organizations asked for equal rights for all Malaysians, the so-called Suqiu claims, which upset many *bumiputeras* and especially the ruling United Malay National Organisation

(UMNO) youth party, whose leaders claimed that the Chinese were trying to create racial unrest in the country. UMNO vice-president Tan Sri Muhyiddin Yassin said that if the Government accepted the Suqiu demands 'national integrity will suffer and Malaysia will not be able to maintain unity, economic growth and racial harmony enjoyed since independence' (*The Star*, 16 December 2000). The special privileges of Malays concerns a number of different societal areas, but in the area of higher education it means that the *bumiputeras* will be granted special scholarships, free tuition and special opportunities to study overseas, among other things. Until 2005, when students entered any of the state universities they were divided into *bumiputeras* and *non-bumiputeras*. The quota-system guaranteed that at least 50% of the students would be *bumiputeras*. Since a much higher number of Chinese and Indian students generally apply to universities, the quota meant that the *non-bumiputeras* had to have much higher qualifications to get accepted. Since 2005, the system has been slightly changed, with a preparatory college year (matriculation) organized according to race-based principles. Currently, there are heated domestic debates about whether the *bumiputera* matriculation schools, which only Malay students attend, live up to the same standards as *non-bumiputera* colleges. Critics argue that this is not the case.

The race-based quota system for university admission is of special interest here, because the special *bumiputera* privileges have opened up an arena for Malay girls to study the classic masculine subject of computer science. They are favoured on the grounds of the race 'positive' policy, and granted student places that possibly would not have been open without the quota-system. As Lagesen (2005: 50) also notes, the proportion of Malay women in computer science courses and at the faculty level at University of Malaya (UM) was strongly influenced by the quota system. As other researchers also have shown (Ng & Thambiah, 1997; Ng, 1999; Luke, 2002; Lagesen, 2005), Chinese and Indian women and men feel discriminated against by the race-based politics. During my study, such feelings were articulated, off-the-record, by Chinese and Indian students, but never openly expressed in class or mentioned by senior academic staff. Viji, an Indian male student stated that he was considering doing his Master's in computer science in Chennai, India, because, he said: 'We non-*bumis* are not getting a fair chance in this system.' Other non-*bumi* students recurrently raised similar concerns in informal conversations. On an aggregate level, there also were indications that the system disfavours non-*bumis*, since the vast majority of the approximately 60,000 Malaysian students that study overseas each year are non-*bumiputeras* (Lee, 1999).[3]

In this perspective, race becomes a more pertinent and pervasive social category than gender, and it possibly and somewhat paradoxically operates more effectively to include women than many other inclusion strategies that have tried thus far. However, in this case, some Malay women are being positively affected by these inclusion measures, while Indian and Chinese women are not.

Situated Body Politics

The articulation of gender, race and class in Malaysia has long been informed by state policies, nationalist discourses and religious cosmology (Peletz, 1996). Nonini (1997, 1998, 1999) points to how Malaysian public spaces are divided by race, class and gender. Drawing on the work of Henri Lefebvre (1991) he shows how public spaces can be understood in relation to three forms of spatiality: spatial practices, representational space and representations of space. While trying to understand how women dominate computer science, I agree that it is crucial to understand the politics of space and bodies. According to Nonini (1998: 341), spatial practices are the embodied habitus and set of routines that people engage in when they move through and appropiate space as users. Representational space is affectively marked in perceptions and memories, and representations of space are visual signs such as maps. The concepts of spatial practice and representations of space are of foremost interest in the multiple ways. Race, class and gender mark out complex webs of spatial practices and representations of space. These fundamental social categories reach deeply into Malaysian society and continuously operate in public as well as in domestic spaces. The dynamics of a situated body politics then has to be understood in various intersections of these social categories. To a large extent, race can be understood as a hierarchy of bodies. This hierarchy also has become inextricably mixed with the hierarchy of masculinities (Connell, 2000) and femininities, as bodies are configured and governed by local gender discourses. The female majority in computer science in Malaysia is a case that illustrates this point.

      The spatial associations of practices with computers, in relation to masculine and feminine bodies, made up a recurrent theme in the interviews and the survey (see also Lagesen, 2005, 2007b). One student, Zaharah, commented: 'IT for me is sitting in an office and do some business. Many men think that the IT-section is not real like engineering and media.' This remark is consistent with what almost all the interviewees said, which is that computer technology is spatially associated with indoor spaces and that such spaces are suitable for women. This also implies that the gendered associations with IT use and computer science, which are familiar from studies of western nations, are more or less absent in Malaysia. Lagesen (2007b) also points to the close spatial association between women, office technologies and indoor spaces. In other words, the spatial segregation of what counts as female and male spaces seems to precede the gender codification of the technology. None of the computer science students I interviewed associated computer technology with specific masculine characteristics. Instead, they expressed surprise that this was the case in western Europe. As Lagesen (2007b: 14–15) also notes, according to her interviewees, hardware network jobs make up a masculine field, because they are more mobile, physical, and involve outdoor exposure not suitable to women. Similiarly, interviewees in my study seemed to presuppose that practices with IT were associated with segregated gendered spaces.

However, when we examine how interviewees suppose that women's work is situated with indoor spaces symbolically connected to computing, it becomes clear that a division solely by gender would misrepresent the complex hierarchy of bodies. Computer science was generally perceived as a suitable occupation for women, irrespective of other social categories, while civil engineering was defined as a masculine field because of its outdoor working environment and exposure to critical situations, such as confronting foreign labourers at construction sites and the like (see also Lagesen, 2007b).[4] Still, it seems that even here there is a certain degree of interpretative flexibility with regard to what counts as 'genuinely' associated with gender, race and spatial practices. For instance, at a dam project on the northern part of the island, a Malay male engineer I interviewed said that women engineers are not fit for civil engineering (Mellström, 2003: 49). That is, they are not fit for outdoor work in the hot sun. At that very moment, I could not help wondering about the chief engineer of the big project, a woman from mainland China who evidently had spent uncountable hours in the hot sun managing the project. As if the Malay engineer had read my mind, he said: 'Well, I mean the female engineers in Malaysia. Engineers from China, they are different.' This is one of many examples in my materials of how gender intersects with race as a social category that operates through different spatial practices, and helps men to create spaces of their own and to keep women circumscribed by a situated body politics with its plethora of rules for what certain women can or cannot do.

Still, in the bigger picture it is no doubt the case that computer science as a professional activity and the IT sector as an industrial realm have opened up new emancipatory possibilities, spatial practices and representational spaces for Malaysian women, although it may not be the Cyberfeminist Utopia that one might have been hoped for (cf. Lagesen, 2007b). So, even though the liberating effect of the association between computing and femininity is regulated within a nationalist and local gender discourse, there is reason for relative optimism that computer science and IT work will offer major improvements for women in the Malaysian labour market, as the nation navigates between influences of 'western modernity' and an emerging Islamic modernity.

Techno-optimism and Emancipation

According to a number of Malaysianists, gender politics in Malaysia has almost always been superseded by race (see, for example, Ariffin, 1999; Mohamad, 2002). Given the totalizing ethnic politics pervading Malaysian society, gender is seldom problematized as a political issue. The women's movement in Malaysia has been organized either by women's groups entrenched in ethnic party politics, who often support ruling ethnic elites, or by feminist organizations organized through non-governmental organizations (NGOs) and located at universities. Maznah Mohamed (2002: 217) distinguishes between the women's movement at the centre and the one at the periphery, but also concludes that even if there is 'an ongoing contest

between these two streams there has also been moments when they colluded for common gains'. Although there has never been a multicultural feminist movement in Malaysia, certain causes have united women from different ethnic groups. This was evident in the labour movement and the anti-colonial struggle for independence in the 1960s, as well as later in struggles against domestic violence and for opening up the labour market for women.

Of special interest here is how Malay women entered IT work and the related electronics industry. Before the influx of large-scale export-led industrialization in the 1970s and 1980s, few Malay women were part of the labour force, and Chinese women formed the majority of female industrial workers (Mohamed, 2002: 223). When Malaysia opened its economy to the global market in the 1970s, export-oriented industries were favoured such as textiles, garments and electronics. Hundreds of thousands of Malay women poured into the new job opportunities, partly because of their perceived dexterity and docility (Ong, 1987; Lie & Lund, 1994; Levidow, 1996).[5] The mass recruitment of this female, largely rural, labour force both changed the composition of the electronics industry sector and opened up a new labour market for Malay women, thus making the electronics industry symbolically associated with femininity. This influx opened up a representational space for women that was implicitly and explicitly referred to by students I interviewed whose mothers or female relatives had worked in the electronics industry. Penang (where USM is located) was a Free Trade Zone (FTZ) as early as the 1970s, and much of the early electronics industry in Malaysia was established there. Consequently, it was not surprising that as many as 34 (50%) of the Malay female students I interviewed had female relatives who had worked there in the electronics industry.[6] Judging from responses to the survey and interviews, even more of the respondents associated electronics in general, and IT work in particular, with the labour market for women. Farah, a 22-year-old Malay female student from the neighbouring state of Kedah said: 'Two of my aunts were working for AMD, two of my cousins for Sony. They all do assembly work. Many women in my *kampung* (village) are going to Penang for work in the factories.'

Consequently, this indicates that the conscious efforts to recruit low-paid women into this industrial sector early on also had some bearing on the symbolic effects and gender codification of IT work. As such, this sector came to represent a new industrial segment without the old gendered and racialized associations of the manufacturing industry associated with pre-independence days. In combination with a general undersupply of 'woman-power' in the electronics industry and a general shortage of computer professionals in the IT sector, there has been what one might term a *reversed symbolic gender appropriation* of the 'western' conception of computing, electronics, and IT work. However, as been pointed out earlier, the electronics industry and IT work have also fragmented the female labour force. On the one hand, there is the low-skilled technology employment, consistent with the image of the 'nimble-fingered' docile female worker, and on the other there is the female professional IT worker and academic.

This is a highly charged and ambivalent symbolic space that nevertheless is occupied by a high proportion of women in a critically important industrial sector in a developing nation. This development in the IT sector also has had impact on wider gender relations in Malaysian society and has challenged notions of an all-encompassing global culture of masculine symbolism and values connected with computing.

Under-achieving Men

The fact that women dominate computer science and many other academic fields also goes hand in hand with a long-standing concern that Malay women outperform men in Malaysian academia, as well as in other areas of the society. This concern points directly to boys and men, and particularly Malay men. As has been publicly expressed for example by Dr Mahatmir Mohammad, former prime minister and Malaysia's dominant political figure for two decades, young Malay boys are not ambitious enough and Malay girls are more serious. In an interview in the English language newspaper *New Straits Times* (29 December 2000), Mahatmir stated:

> In the universities today, over 60% of the students, especially among the Malays, are women and they are studying serious subjects – engineering, science, management, etc, whereas the boys are studying simple subjects which they think they can pass, such as Bahasa Malaysia, Islamic Studies, and Social Sciences [sic!]. And when they come into the government, where are we going to place them? They don't have the capacity to deal with administration, while the women in the universities are studying serious subjects to become the lawyers, the doctors, the engineers, and the scientists. They have shown that they can deliver, for example, a woman who had been sent to space saying that she is highly qualified. So, do I send an unqualified man because he is a man? No, I think it is not the choice that I would choose.

What Mahatmir expresses is also mirrored in recurrent media debates and articulated at different levels of the Malaysian educational system, not least in the state university system. Such debates are part of the Malaysian public discourse as well as more local discussions. For example, a female professor and head of the computer science department at USM stressed that she would like to see more young Malay male students enrolled in her department but that: 'They don't seem motivated enough and we also have problems with young men dropping out of class.' She also mentioned that the department had launched recruitment campaigns at local matriculation colleges, '… but we mostly seem to reach the young girls'. The topic was recurrently discussed in the department, though differently, depending on who was interviewed and what their position was. A young lecturer in the department put the matter more bluntly when she said, '[b]oys are raised that way. Always used to roam around and not taking responsibility. I guess they think they will be head of families anyway so why bother?'

The arguments in this public debate often stress that Malay men must change their mind-sets and wake up to the new world of knowledge-society,

modernity and technological development. Moreover, it is often argued, Malay men lag behind in the development of a pan-Malaysian identity: they remain stuck in their *kampung* mentalities and need to mature and take on more responsibility. Ironically, in this context, Malay men are often portrayed as effeminate, withdrawn from the challenge of forming the *Bangsa Melayu* character; not 'men' enough to to cope with a modernity ruled by a globalized market economy, glossy consumerism and financial nationalism. Accordingly, the emergence of a new middle-class requires Malay men to conform to a Malaysian State doctrine for islamic modernity which emphasizes *agama*, *raja* and *bahasa* on the one hand, and modernity through technological and financial nationalism, on the other. The combination of a heavily male-dominated bureaucratized Islam with a nationalism phrased in terms of modernity, is ultimately based on a global corporate masculinity (see Connell, 2000). However, although there is great variation, many Malay men consider this new masculinity to be 'foreign' or 'western': an import in which '[t]he "State" is metaphorized in men and the village in women, and the former seems more visible than the latter, and hence more powerful and dominant' (Karim, 1995: 26). This new conception of masculinity does not necessarily comply with a bilateral view of gender in which social relationships invert or blur older lines of hierarchy and difference, with their relationships of rank, class and gender. The particular bilateralism of gender relations typical of South-East Asia and Malay cultures, which emphasize lack of formality and avoidance of open conflict, tend to be overlooked by 'Eurocentric' analyses of power relations. As Errington (1990: 5) characterizes it: '[w]e also tend to identify "power" with activity, forcefulness, getting things done, instrumentality, and effectiveness brought about calculation of means to achieve goals'. The prevalent view in many parts of island South-East Asia, however, is that 'to exert force, to make explicit commands, or to engage in direct activity – in other words, to exert "power" in a Western sense – reveals a lack of spiritual power and effective potency, and consequently diminishes prestige' (Karim, 1995: 17). Apparently, this notion of power and manhood is rooted in the sphere of production, the public arena, presumably a hetero-normative masculinity based on successful participation in marketplace competition (Mellström, 1995: 170). Kimmel (1994: 122ff.) characterizes this as *marketplace manhood*, a kind of masculinity that sets standards for other men and women, and against which they are measured. It is a career-oriented form of masculinity in which members of an emerging middle class are supposed to become agents of change and to embody larger spatial-temporal patterns of modernity and globalized industry.

According to this conception of modern masculinity, traditional rural Malay men, accustomed to the confines of custom (*adat*) and a culture of kinship-relationality, become a problem. They are village (*kampung*) people, rejecting change, and their association with a *kampung* lifestyle is metaphorized as effeminate in this discourse of State and market forces. This 'foreign' and globalized notion of a competitive marketplace manhood based on an industrialized masculinity is thus dissonant with classical

Malay notions of (hetero-normative) masculinity in which men's identities and senses of self are formed and based in kin and village relations. These older notions define masculinity, not by reference to men's roles or positions on the economy or political system, but in terms of relations (Peletz, 1996: 322ff.). Accordingly, masculinity is enacted through locally grounded social categories in daily life, such as brother, father, son, uncle, friend and husband. Certain male relational roles, such as father or husband, may have more dominant salience for the category of maleness than would any position in the so-called public arena (keeping in mind that such a 'westernized' concept may not apply here). A different form of hetero-normativity is at stake, as masculinity is performed or enacted through the interrelation between traditional social categories and in relation to reciprocal female roles. This is not say that masculinity stands on equal footing with femininity, but to suggest that classical Malay (hetero-normative) masculinity is a social category composed by a number of relational roles, and contrasts with notions of masculinity based on positions in the global political economy. To conclude, the traditional relational notion of masculinity opens space for women's participation in the positional sphere of a newly industrializing nation such as Malaysia. Many of the responses from young women in the survey and interviews resonated with their anticipated careers and future life-space, with regard to family, and more generally in relation to masculinity, class and race. The politics of space and, as shown earlier, the situated body politics in Malaysia, are of utmost importance for understanding how women have made, and can continue to make, headway into the traditional (in the west) masculine outpost of computer technology.

The Co-production of Computing and Gender in the Malaysian Context

In the final part of this paper I shall look more closely into the co-production of computing and women's work by following threads from the interviews and survey, which also link closely to previous research (for example, Ng & Yong, 1995; Ng & Mohamad, 1997; Ng & Thambiah, 1997; Margolis & Fischer, 2002; Lagesen, 2005, 2007a,b). In the upper echelon of women's IT work, where most of the interviewed students from computer classes at USM were likely to work in the future, it is evident that numbers and role models matter. As many as 51% of the female students answered that they thought that IT-related occupations, such as systems analyst, programmer, lecturer at the university and web designer, were available for them in the future because they had seen other women in those jobs. The students mentioned female lecturers at USM as sources of inspiration (see also Lagesen, 2005, 2007b) as well as alumni, who lectured in the department on a regular basis. Azlina, a third-year student recalled, 'this former USM student came the other week, and she was really successful, and everything she said was so inspiring.' In other words, the gender-balanced composition of computer science, combined with the number of women acting as role models through lecturing and working in IT businesses were very important for opening the representational space of computer science. As Lagesen (2007b: 87) also notes, this

combination of factors opens up for a more flexible gender coding of computing and computer science. Whether or not such symbolic openness also caused significant change in the social environment was beyond the scope of this study, but since men have never dominated computer science in Malaysia, respondents such as Azlina had every reason to believe that the openness in the job marked would continue. Even to raise questions on this topic often elicited surprise, such as in a response from a second-year student, Maimunah's: 'Why do you ask that? Is that a problem?' When getting such responses I tried to explain that it is a problem in western countries, which was why I was interested in the Malaysian case. The theory that a critical mass of women is necessary to secure a gender-balanced recruitment is frequently discussed in research on women in science and engineering, and computer science in particular (Margolis & Fischer, 2002; Lagesen, 2007b). However, in academic as well as everyday discourse in computer science departments, it seems that gender-balance simply isn't discussed as a problem. A preoccupation with this question by western researchers like myself may strike respondents in this context as an imposition of an irrelevant concern. For them, race and class, interspersed with certain mainstreamed gendered questions, are more salient to concerns about exclusion and inclusion in higher education and professional careers. Gender is not necessarily articulated as an issue in the professional sphere, as long as it is confined to the familiar symbolic as well as material spaces that I discussed earlier. In other words, gender is much less salient in relation to race and class. More salient was the combination of relational and positional roles: how the 'public and private' interrelate, or how women in computer science and IT-related work manage their juxtaposition. Many of the female students in the survey and interviews spoke of how they try to balance family life with their careers.

For example, Atikah, a Malay female student said, '[I]t is very important that I can take care of my family first but also to make a career.' Most of the female students, irrespective of ethnicity, anticipated having full responsibility for their future families – with raising children and household work.[7] Male students did not anticipate such responsibility, although five men mentioned it. One conclusion that can be drawn from such responses is that the domestic division of labour was not questioned. Instead, female students anticipated having to find viable solutions for managing a professional career in combination with family responsibilities. As one of them, Zaharah phrased it: 'I will pursue a career until I reach 35, maybe 40, and then I will stay home with my children and husband.' Of course, such responses did not mean that the female students actually will withdraw from the labour market when it is time to raise a family, and many said that they chose to study computer science because it can be combined with family responsibilities. Apparently, they imagine this to be easier with academic jobs, as Atikah pointed out: 'I would not mind to become a lecturer because it seems to be flexible with family and everything' (see also Lagesen, 2005).

Employment statistics indicate[8] that there is a 'leaky-pipeline' effect in the ICT sector as a whole, which is segregated in terms of class and

ethnic cleavages. Many urban women pursue full-time professional careers until about the age of 55 years (the average female retirement age in Malaysia). They seem to be able to do so in industry and academia without losing status and career opportunities, while women in many lower-income factory jobs tend to leave the workforce at an earlier age because of pregnancies, childcare and other family obligations. A tentative conclusion about this pattern is that opportunities for women mirror the structure of a fragmented labour force in a highly stratified multiracial society. In the science, engineering and technology sectors, race, class and age are no less crucial than gender is for determining career opportunities. The 'leaky pipeline' effect may be hard to trace for women in science, engineering and IT professions, but the it surely can be observed in particular industrial sectors in which many women move out from the labour market between the ages of 35 or 40 years, or never enter it at all, depending on their race and class.

Female students also expressed a great deal of ambivalence in their responses to my questions, probably reflecting the pressures that many young women in contemporary Malaysia experience. These pressures include social demands that arise from a gender paradigm that works in parallel with a positional labour market in which many young women perform especially well for many years. This labour market has been open to them, due to a combination of race-based quota-politics, a shortage of computer professionals, and a flexible gender codification system in computing. Nevertheless, this openness takes place in a social order that is still very much based in relational characteristics and the 'politics' of family relations.

This ambivalent situation has much to do with how the Malaysian state and nation are in the process of being metaphorized as an 'extended family' (see Yuval-Davis, 1997; Hylland-Eriksen, 1998). In a newly developing post-colonial nation, with a distinctive nationalist state politics building on *agama, raja* and *bahasa,* citizens are expected to share a familial sense of commitment to these values. Such commitment evidently varies among the different ethnic groups, due to past and present politics of inclusion and exclusion in the imagined community (Anderson, 1991). However, the very idea of an extended national 'family', implying paternalistic family and kinship relations at a national scale, also supports gender relations that are important for how computer science and IT work was viewed with techno-optimism by many Malay women in my survey and interviews. Their responses can be interpreted through this naturalized and 'primordial' image of the nation (Yuval-Davis, 1997: 15), in which educational and occupational choices are connected with and dependent upon familial relations. Two quotes illustrate this point: 'My parents want me to be someone that can give something in order to help my country' (Zanir, second-year student); 'I must help to develop our country to be more technologically advanced' (Azikah).

The desire to help build the nation is strikingly recurrent in responses from Malay female students, who speak of going into a field

filled with promise for their own, their families', and their nation's future. They are very explicit about the responsibility they feel for their families and their country. In contrast to the Malay female students, Chinese and Indian students, irrespective of their gender, expressed very different views. Responses from male Malay students also differed, though to a lesser degree, from their female counterparts. Not surprisingly, the sense of communality is much less pronounced among the *non-bumiputeras,* as the very term suggests. Approximately one-half of the *non-bumiputera* students said that they planned to enter the transnational job market in countries such as the UK, USA, Australia, New Zealand and Japan. Such plans seemed realistic, given the large diaspora of Chinese and Indian populations from Malaysia (Mellström, 2003) that provide extensive transnational networks of mobility for students from those populations.

In sum, a number of factors are salient in the co-production of gender and computing in the Malaysian context. In my view, these factors point to the temporal and spatial variability and flexibility of gender and technology relations. To discern where, why and how technology is being symbolized and codified in Malaysia requires a thorough and locally informed gender analysis.

Conclusions

In this paper I referred to an eclectic set of data on women and computer science in Malaysia, and stressed the importance of investigating how gender and technology relations are embedded in specific cultural contexts. With the aim of opening up gender and technology studies to cross-cultural comparisons and intersectional analyses, I took up a familiar concern with the representation of women in science and engineering, and examined a case in which women dominate a field – computer science – that in western countries is predominantly a male domain. Inspired by recent critical interventions in feminist technology studies, I argue that gender and technology studies need to pay more attention to culturally situated analyses that bring local gender discourses into the picture. Computing and computer science are numerically dominated by men and symbolically charged with masculinity in many western countries, but in Malaysia they are situated within local gender discourses that change the polarity of the 'charge'. It is thus crucial to investigate relational aspects of gender, including positional relations of women and men with other relevant social categories intersecting and shaping gender relations. I hope this paper has demonstrated why it is of crucial importance to situate men, power and technology in such local contexts. I also addressed a form of analytical asymmetry that characterizes the process of co-production thematic to gender and technology studies, by discussing a case in which particular practices that dictate a priori which occupational and technological spaces are

appropriate for specific gender categories. Accordingly, this paper casts doubt upon the notion that an all-encompassing masculine culture of science and engineering transcends time and space. It also offers a critique of a western bias of gender and technology studies, which can lead to context-insensitive analyses of the cultural situatedness of gender and technology relations.

Notes

1. I have elaborated elsewhere (Mellström, 2009) on the survey results of this research. In this paper I am rather concerned with general theoretical arguments.
2. A dialect I have mastered to a certain degree, because of earlier anthropological fieldwork in Penang (Mellström, 2003).
3. Available at <http://aei.dest.gov.au/AEI/PublicationsAndResearch/MarketDataSnapshots/MDS_No05_Mal_pdf.pdf> (accessed 6 December 2008).
4. This account reflects the xenophobic characterizations of foreign guest workers in Malaysian media, 'aliens' as they sometimes are called (The Malaysian Daily, *The Star*, 14 January 2000).
5. From 1970 to 1980, female workers in the manufacturing sector increased from about 70,000 to about 300,000 (Mohamad, 2002: 223n. 5)
6. Many of the students are locally recruited, meaning that they come from nearby northern states of Malaysia, such as Penang, Perlis, Kedah or Perak. A 'relative' can also mean a person in the extended family, and generally Malay families are large.
7. This category made up 73% of the female students.
8. In the Malaysian labour force, participation rates vary by sex and age group. We can see that in the age group 25–34 years, men comprise 97.2% and women 61.6%; in age group 35–44 years, it is 98.3% and 52.1%, respectively; and in the 45–54 year group, it is 94.7% and 44.5%, respectively. This fluctuates considerably, however, depending on the industrial sector, occupation and educational diplomas in question. In the upper and high-income branch of the ICT sector, the effect seems less pronounced, according to the lecturers and professors at USM that I interviewed. However, there are no available data to confirm this assessment. (Source: Labour Force Survey Report, First Quarter 2007, Malaysia, Series No. 10, No. 2/2007, August 2007, Department of Statistics.)

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Ulf Mellström is Professor of Gender and Technology Studies at Luleǒ University of Technology, Sweden. His research interests are gender in science and technology, in particular cross-cultural comparative perspectives, engineering, masculinity studies, and Malaysia. He is the editor of the *Nordic Journal for Masculinity Studies (NORMA)*. Key publications include *Masculinity, Power, and Technology: A Malaysian Ethnography* (Ashgate, 2003), and 'Patriarchal Machines and Masculine Embodiment', *Science, Technology, & Human Values* 27(4), Autumn 2002: 460–78.

Address: Department of Human Work Sciences, Division of Gender and Technology, 971 87 Luleå University of Technology, Sweden; email: Ulf.mellstrom@ltu.se

Appendix

Perangkaan Tenaga Buruh [Labour Force Statistics], Malaysia 2006

Ciri-ciri [Characteristics]	Jumlah [Total]	Lelaki [Male]	Perempuan [Female]
Penduduk (juta) [Population (×10⁶)]	26.6	13.5	13.1
Penduduk umur bekerja (×10³) [Working age group] (×10³)	16,834.0	8563.1	8270.9
Tenaga buruh (×10³) [Labour force] (×10³)	10,628.9	6843.5	3785.4
Penduduk bekerja (×10³) [Employed persons] (×10³)	10,275.4	6618.6	3656.8
Bilangan penganggur (×10³) [Number of unemployed] (×10³)	353.6	224.9	128.7
Luar tenaga buruh (×10³) [Outside labour force] (×10³)	6205.1	1719.6	4485.5
Kadar penyertaan tenaga buruh (%) [Labour force participation rate] (%)	63.1	79.9	45.8
Kadar pengangguran (%) [Unemployment rate] (%)	3.3	3.3	3.4
Pekerjaan [Occupation]	10,275.4	6618.6	3656.8
Penggubal undang-undang, pegawai kanan dan pengurus [Legislators, senior officials and managers]	829.6	635.7	193.8
Profesional [Professionals]	565.9	314.9	251.0
Juruteknik dan profesional bersekutu [Technicians and associate professionals]	1,307.5	797.7	509.8
Pekerja perkeranian [Clerical workers]	968.3	289.7	678.6
Pekerja perkhidmatan, pekerja kedai dan jurujual [Service workers and shop and market sales workers]	888.5	708.6	1597.1
Pekerja mahir pertanian dan perikanan [Skilled agricultural and fishery workers]	1335.9	993.4	342.5
Pekerja pertukangan dan yang berkaitan [Craft and related trade workers]	1154.8	1002.0	152.7
Operator loji dan mesin serta pemasang [Plant and machine-operators and assemblers]	1408.0	1004.4	403.6
Pekerjaan asas [Non-skilled occupations]	1108.4	692.3	416.1

NOTE: Source: Labour Force Survey Report, First Quarter 2007, Malaysia, Series No. 10, No. 2/2007, August 2007, Department of Statistics.