Break the Pattern!

A critical enquiry into
three scientific workplace cultures:
Hercules, Caretakers and Worker Bees

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UPGEM Understanding Puzzles in the Gendered European Map

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ISBN: 978–9949–11–995–0

Printed in Estonia at Tartu University Press, Tartu
www.tyk.ee

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Preface

In the forewords to *Draw the Line! University as workplaces for male and female researchers in Europe* and *Draw the Line! International Conference, Copenhagen 2008. Papers, proceedings and recommendations* I have as co-ordinator thanked many, who have contributed to this three year long project funded by the European Commission. These people include colleagues at universities across the world, people in the EU-system and the Research Directorate General of the European Commission as well as politicians. I would like to thank all of them again collectively.

I would like to direct a special thank to Lars Qvortrup Dean at DPU, University of Aarhus for supporting the project in the last critical phase.

We would also like to thank the physicists who have allowed us insight into their world of physics. Though we have pointed to a number of problems in the physics environments, we have primarily encountered very considerate, non-discriminatory, interested and enquiring informants. It is important to note that though we have concentrated our efforts on physics, we are certain that many of the selection mechanisms we have found apply to physics most probably also apply to the wider university sector and maybe beyond.

Break the Pattern! is a special project publication because it draws on the research work done by all the research assistants and partners in the project and combines this with new analyses made by the Danish team. The essence of these culture contrast analyses have been discussed along the way with the partners and assistants with first-hand knowledge of the Italian, Finnish, Estonian, Polish and Danish cultures. However, the overall perspective of this publication largely reflects the efforts of the Danish team.

On behalf of the Danish UPGEM team, I would like to thank all of our supportive UPGEM partners who have participated eagerly in our

discussions over the years, as well as our hardworking, thorough, inspiring and engaged research assistants. The core group of assistants is: Katrin Velbaum, Christina Belardi, Giulia Calafiore, Jenny Vainio, Anne Bjerregaard Sinding, Lone Svinth, Stine Trentemøller, Agata Heymowski, Patrycja Chudzicka-Dudzik, Anna Diekmann, Malgorzata Miazek.

For my own part I would like to extend this thank to the incredible team in Denmark, who in the last phase of the project has worked very hard to make this publication possible: Anne Bjerregaard Sinding and Agata Heymowski for their analytical contributions and Søren Kyd Jacobsen for his ability to patiently keep an overview of important details. Lastly, I wish to thank my co-author of all of the chapters presented in this publication Stine Trentemøller, who since the project began in 2005 has worked indefatigably and with extreme competence on all aspects of the project from co-ordinating the other research assistants' work and systematizing data material to the analysis and writing of the chapters presented in the following pages.

I have learned a lot from all of you and want to thank you all for being supportive, critical and engaged colleagues. Ultimately, any error and shortcoming of the analysis presented in this publication falls back on me, whereas all qualities and virtues must be seen as the result of a truly collective activity.

Cathrine Hasse,
Co-ordinator

1.0 Introduction

Understanding Puzzles in the Gendered European Map (UPGEM)[1] is an international collaboration between Denmark, Estonia, Finland, Italy and Poland. The project examines the influence of culture on everyday life at university as a workplace. One important aspect of the project is the exploration of culturally and historically formed differences in gendered career paths in physics. Another aspect is uncovering any possible reasons for leaving or continuing a career as a scientist in physics in academia. The UPGEM project has previously published five national reports[2] which deal with both of these aspects. In this publication, we investigate the complexity of the professional everyday work life in academia while taking up the analytical, theoretical and methodological challenge inherent in working with this complexity. We present the cultural patterns that have emerged in our analysis of universities as workplaces taking the physicists' activity as our case, but judging from our own experience, the analysis of the selection mechanisms could easily be applied to other disciplines in academia.

We also discuss how career paths of male and female physicists are conditioned by these cultural patterns and how male and female physicists are given different conditions for developing as scientists in relation to a number of themes such as time management, family life, work place identities, selection (i.e. inclusion and exclusion) mechanisms, creativity and hierarchy.

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[1] UPGEM is financed by the European Commission's 6th framework programme "Structuring the European research area, Science and Society; Women and Science" from September 2005 to September 2008. The project partners were Cathrine Hasse (Co-ordinator), University of Aarhus, DPU, Denmark; Kristina Rolin, Helsinki School of Economics, Finland; Anna Maria Ajello, La Sapienza, Italy; Endla Lõhkivi, University of Tartu, Estonia, Yrjö Engeström and Merja Helle, University of Helsinki, Centre for Developmental Work Place Research, Finland and Elzbieta H. Oleksy (until November 2007), University of Lodz, Poland.

[2] See *Draw the Line!*

The project is structured around a core group of qualitative researchers with a senior partner and one or two research assistants in each UPGEM country. In all, UPGEM consists of 18 research assistants covering interests and disciplinary backgrounds from anthropology, philosophy, gender, culture studies, psychology and linguistics.[3] We have, through interviews and participant observations in the home countries, compiled a database of more than 16,000 relevant quotes from 208 interviews (50 from Poland and Italy, 36 from Denmark, Estonia and Finland) for our work in this publication) with physicists who are active or have left physics research after having embarked on a Ph.D. degree.

The different working conditions and research backgrounds of the researchers have added to the complexity of the data material. We have turned this complexity into one of the strong points in the collaboration as it has strengthened the use of the culture contrast method. This method builds on a model of analysis in which culturally formed connections are contrasted. The model of analysis is a refinement of the notion of cultural learning processes (Hasse 2002) and will be presented in more details in Chapter 2.

More specifically, the overall objective of UPGEM is to understand the cultural diversity in the proportion of female physicists employed at universities across Europe. Like the few studies which have looked into this issue (Carlson 2000; Barinaga 1994; Megaw 1991), we have also found that the proportion of women employed as physicists differ from country to country.[4] We found the highest proportion of female physicists is Italy where women constitute 33% of the associate professors

[3] The research assistants who have at one point contributed to the project either by conducting interviews, coding and analyzing transcripts, made quantitative data gathering and analysis or co-authored the reports were: Katrin Velbaum and Mari-Liis Tina (Estonia); Christina Belardi, Giulia Calafiore, Piera Gabola and Cristina Cimino (Italy); Jenny Vainio (Finland); Patrycja Chudzicka-Dudzik, Anna Diekmann, Malgorzata Miazek and Bartek Zwardon (Poland), Agata Heymowski (Denmark/Poland), Stine Trentemøller, Anne Bjerregaard Sinding, Lone Svinth, Maja Hojer, Lena Dannow and Ane Bentzen (Denmark)

[4] See Appendix III for the figures found in the UPGEM head count.

and 23% of the full professors. In Denmark we found the lowest number of female physicists who constitute 10% among the associate professors and only 3% of the full professors (Svinth, 2008, 41). In a wider perspective of women in science we find an even greater diversity between top and bottom scores (European Commission 2006; Thörngren et al. 2002)[5].

Over the years, several explanations have been offered as answers to this cultural diversity. A number of reasons were listed in a special issue of Science in 1994 (Barinaga 1994) relating, among other surveys, to Jim Megaw's survey of female physicists (1991). As described by Svinth (2008) and Carlson (2000), Megaw (former Chairman of the Physics Department of York University, Ontario, Canada) sent out a survey to a thousand university physics departments all over the world. The result showed a high variation in relation to the number of women employed at physics institutes; the most industrialised countries had the lowest percentage of female staff. Moreover, the "10 countries with the largest female physics faculty percentage included three Mediterranean countries, Portugal, Italy and Turkey (with Spain and France in 11th and 12th place); three Asian countries, Philippines, Thailand and China; three Eastern European countries, Hungary, USSR, Poland and Brazil. By contrast, the countries with large physics establishments, high levels of industrial development, and strong women's rights movements provided six of the ten countries with the smallest female physics faculty percentage: Canada, Germany, Norway, USA, UK and Netherlands" (Carlson 2000, 11). Denmark is not included in Megaw's survey but is among the countries with the lowest percentage of female faculty staff (Hasse 2008).

Combining the reasons for the differences in the percentage of women employed at physics departments reported by Megaw, Carlson and Barinaga, we can compile the following list of explanations:

[5] A number of other reports also illustrate this diversity (see for instance the homepage of the International Union of Pure and Applied Physics: http://www.iupap.org and the Working Group on Women in Physics: http://www.if.ufrgs.br/~barbosa/women.html). A consistent pattern seems to be that eastern and southern European countries have a higher score in percentage of women working as professionals in physics.

- Differences in perceptions of education (girls schools, compulsory teaching of physics).
- Differences in the economic development and the labour marked.
- Differences in perception of class in relation to gender.
- Differences in the prestige of science (and subsequently in the researchers' salary).
- Differences in religious influence in protestant and catholic countries.
- Differences in state support of child care.

It should be noted that these diversities relate to explanations at different levels. Some deal explicitly with physics, while others have a broader perspective. In fact, a number of the latter explanations tend to be based on common sense observations rather than basic research. Furthermore, we find that reasons given in one context may be contradicted by reasons given in another context.

One of the arguments behind the first explanation is that a high number of female physics students will lead to a high number of female physicists at university level. Two conditions have been presented as reasons why some countries have more girls studying physics in secondary school – girls' (only) schools and compulsory physics teaching in secondary schools. Carlson (2000) list as an explanation, that southern European countries have many female physicists because girls, in these countries, have traditionally attended girls' schools. At the British Institute of Physics (ibid., 14) more than half of the women had attended a girls' school. Yet, though Great Britain has some girls' schools, the overall number of female physicists in Great Britain is lower than countries which do not have girls' schools. Many of the eastern European countries, where we find many female physicists, do not have boys' and girls' schools.

On the basis of the UPGEM research it appears that the impact of girls' schools does not provide the sole explanation, as we still find great variety and complexity across national cultural contexts. To give an example, a novel finding in UPGEM is an unproblematic connection between classical studies and natural science in some countries. As a result, boys and girls with a background in classical studies are allowed

to study physics at university, which results in a high intake of female physics students (see Hasse 2008 and Chapter 3). Thus it seems that the explanation is not to be found in the gender segregation alone.

The first explanation in the list also point to physics and mathematics as compulsory topics in school. In the United States, where physics and mathematics are optional subjects in secondary school, the percentage of female physicists is low. Yet, in many of the eastern European countries and countries of the former Soviet Union, where physics and mathematics are and have been compulsory in secondary school, we generally find a high percentage of women in the staff at physics departments. Carlson notes that "with science subjects being taught in progressive courses at every grade level, [these countries] have been able to attract more girls and women to science than countries in which these courses are elective" (Carlson 2000, 14). The UPGEM research cannot fully support this thesis, however, as we find internal differences between the former communist countries in the project. Estonia stands out from many eastern European countries by having almost as low a proportion of female staff at physics departments as Denmark with respect to associate professors.

The second explanation relates to differences in the economic development and the labour market. Beatriz Ruivo (op. cit. Barinaga 1994) has argued that women have been more easily accepted in science in countries with developing economies and in countries where science has not had a long tradition of male dominance. Ruivo argues that in national contexts where science constitutes a younger domain important for rapid economic development, women are given a chance to compete on equal terms with men because science is not yet established as a male dominated field. Thus, the implication of Ruivo's argument is that even though women's entrance into the labour market happened at a later time compared to the more developed countries, the field of science is an opportune profession because it is a younger domain.

In the Estonian national report (Velbaum, Lõhkivi and Tina 2008) we see that Estonia, which could be classified as a developing economy, has very few female physicists, whereas in Poland, which is also a developing economy, we find many female physicists. Put differently,

these examples indicate that it might not solely be a question of having a developing or developed economy which determines the share of female physicists at universities.

Within the UPGEM frame, we find a more gender segregated labour market in the northern European countries – a gender segregation which seem to be replicated within science. In Denmark, where almost all women are in employment, the labour market is characteristic of being highly gender segregated; women's occupations typically occur in the categories of nursing and teaching whereas men's occupations traditionally include programming and the army. At university, gender segregation also shows itself by women typically studying the so-called soft sciences while men tend to study the so-called hard sciences. In Italy, however, women constitute a comparatively small part of the workforce but take up a wide range of occupations. At universities they are will represented in areas which are thought of as 'male areas' (e.g. physics and information sciences) in Denmark (Hasse 2008). Following the above argument, it appears that in countries with proportionally fewer women in the labour market, the representation of women in scientific fields seems to be higher compared to countries with a high proportion of women in the labour market.

The third explanation we have listed is the mentioning of differences in notions of class in relation to gender (see Barinaga 1994) as a possible explanation for the higher number of female physicists found in southern European countries and in some parts of Latin America. When gender is counterbalanced with class, two types of societal hierarchies appear. In a 'Gender Society', the hierarchy can be described as follows:

Rich man – poor man – rich woman – poor woman

In a 'Class Society' the importance of class overrules gender forming the following hierarchical order:

Rich man – rich woman – poor man – poor woman

The UPGEM results show that in Italy, which is predominantly a Class Society, family background and educational background (a classical background is a sign of being an educated person) seem to be of greater importance than gender in physics, whereas class (in terms of family background) seems to be of little importance in Finland and Denmark. However, the implications of gender versus class do not offer a satisfactory explanation to the diverging percentage of female staff at physics faculties in the UPGEM countries, as neither Estonia nor Poland can be labelled class societies or gender societies. Moreover, in Poland women often seem to reach high positions in physics, while this is not the case in Estonia.

As mentioned in the above list, the prestige of science and the subsequent salary of scientific researchers have also been pointed to as reasons for national differences in the number of female physicists. Again, Carlson (2000) notes that a low level of prestige of science correlates with a high percentage of women in science, whereas a high level of prestige of science results in a low percentage of female scientists because prestigious disciplines tend to be established by males and thus characteristic of male dominance. Ruivo also underlines that the high proportion of women in science in Portugal may rather reflect a low level of esteem of science than a high regard for women (op. cit. Barinaga 1994, 1469). However, the UPGEM research has not found signs of science suffering from particularly low prestige in countries in Eastern Europe and the former Soviet Union. However, we see no connection between high prestige and low numbers of women, as physics was very prestigious in the Soviet Union (Velbaum, Lõhkivi and Tina 2008, 150) (as it was in Estonia and Poland) where it was a way to make international contacts and travel. In the last decade, however, the prestige of physics has decreased in varying degrees in all the UPGEM countries.

Another argument is the impact of religion on the percentage of women at physics departments. Protestant countries generally have a low percentage whereas Catholic countries have a high percentage (Barinaga 1994; Megaw 1991; Carlson 2000). In Chapter 3, we show that a similar pattern is found in the UPGEM project. Italy and Poland have the highest percentage of female faculty staff in physics while the

three Protestant countries, Estonia, Finland and Denmark, have the lowest proportion. The explanation put forth by Megaw, Carlson and Barinaga is that Catholic countries tend to have many girls' schools which could explain a higher percentage of female faculty staff in physics. As mentioned above, the research in the UPGEM project has not found support for a positive impact of girls' school.

In studies of changes in family politics in the twentieth century, religion still seems to influence greatly the perception of appropriate gender roles regarding domestic chores and the workplace (Inglehart and Norris 2003). In an analysis of the degree of religiosity in post-industrial nations, Inglehart and Norris categorise Italy as a very religious country and Finland as a highly secular nation. We find that in Italy and Poland (i.e. the Catholic countries in the UPGEM research) religion seems to generate a particular view on women as strongly connected to children. In Chapter 3, we argue that it is not so much the connection between religion and the educational system that opens up access for women in physics, but the connection between the given religion and the associated societal gender roles.

Finally in the UPGEM research we came across a new correlation as a possible impact factor. The two countries with the proportionally lowest share of female physicists are small population countries, whereas the two countries with the proportionally highest share of female physicists are big population countries. Yet, if we turn to the research put forth in e.g. the IUPAP study referred to by Lone Svinth (Svinth 2008), we find no convincing indications that the size of the population matters. In the special issue of Science, it is explicitly mentioned that countries with "large physics establishments, (…) such as the United States, Britain and Canada, have among the poorest records, with women representing fewer than 5% of physics faculty" (Barinaga 1994, 1468).

Our aim is not to disallow the reasons put forth by others, but to draw attention to the fact that they only seem to function as explanations at a local cultural level. Put differently, they are unable to provide satisfactory explanations to the cultural diversity. More girls' schools might increase the number of female physicists at universities, and better childcare facilities might improve the situation in Italy even

though it has not led to a higher percentage of female physicists in Denmark and Finland. But, these suggestions apply to local contexts and are not applicable to all cultural contexts.

At a first glance, it appears that the inclusion and exclusion mechanisms which affect the proportion of women in the physics activity operate 'outside' physics. Thus, it is possible that the problems for women in physics can be solved 'outside' the discipline of physics. If that is the case, we would expect to find physics as an isolated, uniform unit of activity, as the physicists themselves perceived their activity to be. In the words of the anthropologist Sharon Traweek, physicists perceive their profession as an "extreme culture of objectivity, a culture of no culture, which longs passionately for a world without loose ends, without temperament, gender, nationalism or other sources of disorder – for a world outside human space and time" (Traweek, 1988, 162)

The question is how many of the above mentioned cultural diversities are related to nationally formed conditions outside the discipline of physics or selection mechanisms formed within the discipline of physics. To explain the latter, two metaphors have been used. These are the *leaking pipeline* (Alper 1993) and the *glass ceiling* (e.g. Rosser 2004). These metaphors describe complex situations in science which have not been fully examined. To our knowledge women do not exceed or come near 50% of the leadership or other high positions in physics in any of the UPGEM countries. Therefore, it is safe to say that the glass ceiling does exist in all the UPGEM countries. Many of the above explanations may hold some truth in trying to explain this fact, but the situation proves to be more complex when we get closer to the everyday life of the interviewed physicists in the UPGEM project. In this context, we see that a wide range of cultural historical processes in play, and to capture the many complex processes in one analysis is a major challenge as it is problematic to capture the essence of the relevant connections 'outside' physics (physics *in* culture) and the connections 'inside' physics (physics *as* culture) simultaneously.

When taking activity theory as the theoretical framework, the activity of physics can be seen as an activity in itself. Yet, we also find it useful to perceive the activity of physics as embedded in a jumble of national cultural activities. In order to grasp the complexity of physics

as a national activity (physics *in* culture) and physics as an isolated activity (physics *as* culture) in our analysis for this publication, we found it necessary to further develop the activity theoretical tool that was applied to our analyses of the national sets of data presented in *Draw the Line!*

One way to a better understanding of this great complexity of cultural variations is the very concept of culture. The concept of culture that we have as the foundation for our research of workplace cultures in physics consists of two aspects:

A. Culture as an 'empirical fact' is only to be found in the analysis of contrasted relations. In this context culture as an empirical fact functions as a tool for the analysis. What counts as empirical data on culture is formed by the researchers in a co-creation with their informants. Such empirical data on culture can be contrasted with similar empirical data generated by other researchers working in other (national) contexts. In this analytical process, implicit cultural comparisons (Hasse 2002, 17) are made explicit because the informants' and the researchers' self-evident meanings are challenged.
B. Cultural meaning can also be understood as something other than an analytical process. It can also be seen as empirical or actual clusters of connections that form a directive force in people's lives, and which can be argued to include or exclude people from certain workplace activities (Hasse 2002, 14). Our notion of culture as a directive force is tied to the notion of cultural learning processes, which form self-evident clusters of connections that change over time and thereby challenge our perceptions of the world.

The very progress of research in what comes to constitute 'culture' is thus a process, which is as emergent and movable as culture itself. The analytical strategy following this principle is to look for patterns of self-evident meaning in the local (national) analyses made by local researchers in the five UPGEM countries and pursue these by using the culture contrast method.

In the culture contrast method we combine activity theory with a theory of cultural connectionism to grasp diverging cultural and national inputs. The method is to contrast the clusters of connections, which we define as cultural models (Holland and Quinn 1987a). These

clusters are constructed through national activities and shape (like a real force) notions of possible conduct in areas of everyday life like education, family and work. In using the culture contrast method we look at the activity of physics in culture and as an isolated unit (physics *as* culture). Thus we employ, as a novel aspect, the theory of cultural models in a cross-national culture contrast analysis and we find clusters of cultural models which function as selection mechanisms in (inclusions and exclusions from) the activity of physics.

In Chapter 3.0 we employ the culture contrast model as our analytical tool to gain insight into the issue of differences in state support of child care, as it often comes up as an important factor in women's possibilities of making a career in science. Particularly lack of day-care centres, nurseries, kindergartens and proper conditions for maternity leave are seen as the main obstacles for women's advancements. We have, however, found a noticeably lower proportion of female physicists in the UPGEM countries with much state supported childcare (Finland and Denmark) compared to a country lacking state support (like Italy).

When we contrast findings from the five UPGEM countries, we find different cultural models of integrating children and family life in the activity of physics. In some models children, as such, do not constitute the overall problem for women's career paths. Here, the majority of the female full professors have children (and often more than two children). In fact, to our surprise we find the highest percentage of mothers in the staff at the Italian physics departments and the lowest percentage of mothers in the staff at the Danish, Finnish and Estonian physics departments.

We do not interpret these findings as an argument against the need for state supported childcare, but as an indication that plentiful day-care centres etc. cannot alone solve the problem. Moreover, it is as an indication that our model of analysis used to identify separate national cultural models has not reached the core of the issue. Instead we find it constructive to adjust the model of analysis to include clustering of cultural models in physics *as* culture.

In Chapters 4 – 6 we investigate the notion of physics as a culture of no culture by applying the culture contrast method to identify and

contrast *clusters* of cultural models within the activity of physics (i.e. physics as culture).

We have identified three clusters of cultural models, which can be argued to function as different frames within which the inclusion and exclusion of scientists take place. The three clusters can be described as forming three ideal type scientific cultures forming the activity of physics. We have named the three culture types *Hercules*, *Caretakers* and *Worker Bees*.

One of the issues we will look into is the different perceptions of how science and family life should be connected. In the Hercules culture we find physicists who prefer to keep family issues at an arm's length of science in order to devote their life to science. The Caretakers, however, see no problem in integrating family and work life and the Worker Bees prefer to separate work from family life and give priority to the family.

At every step of our analysis we have found more levels of complexities in the explanation of why we find a higher proportion of female physicists in Italy and Poland compared to the other UPGEM countries. By using the method of culture contrast for the analysis of both physics *in* culture and physics *as* culture, we are able to identify clusters of cultural models for how to do physics in an acceptable manner. On the basis of this analysis, Chapter 7 ties together how cultural models from physics in culture and gender can be tied together. We argue that the mechanisms inherent in each of the ideal type cultures ascribe meaning to gender and thus construct different types of glass ceilings. Moreover, we discuss whether one ideal type physicist is more or less salient in certain national workplace cultures and thereby generates different conditions for career paths in physics for men and women.

2.0 Culture Contrast and Connectivity: methods, methodology and theory

The objective of the UPGEM research is to comprehend in what way cultural historical learning processes form universities as workplaces at which gendered inclusion or exclusion of scientists takes place. The phrase 'cultural historical learning' will be recognized by social scientists, psychologists and educationalists as belonging to the theoretical framework of cultural historical activity theory (CHAT). According to this line of thought, human beings create dynamic activity systems in dialectic relations between themselves and their social and material environments throughout the course of history. Human beings have agency, but the agency is embedded in historically created practices, artefacts and institutions. CHAT aims to study these human practices as consistent historical processes of development, which evolve in the interface of individual and social learning processes.

This theoretical framework has been the foundation of UPGEM throughout the project, and in this chapter we link it with the methodology and concrete methods employed in the research work. In this publication, we view the physicists' activity as one which is a) embedded in national culture b) forming its own culture and one which is.

In this chapter on methodology, we argue that culture entrenches connectivity in modes that can be identified as 'cultural models' and that these different learned cultural models of connections can be difficult for a researcher to identify. This difficulty is chiefly because a researcher's own cultural models make it difficult to recognize any self-evident aspects about their own connections. Cultures can be found in contrasts and we (researchers as well as informants) are all cultural beings, which researchers must acknowledge. As researchers, we might discover learned connections, which were unknown to us, when we have determined the framework within which the connections are to be searched. In this sense, our research is always relational and dependent of our mode of inquiry. In the first part of this publication we look at physics *in* culture, where the demarcation of possible contrasts of connections occurs in the national cultures in the project. These

connections, we argue, are made through cultural historical processes, which are primarily played out in the activities tied to the nationalities in the project. As shown the further analysis, perceiving physics *as* culture can in a cultural historical framework, also be seen as an activity – which forms its own connections across national borders.

Overall, the project collaboration has gone through three phases which have resulted in different outputs.

- In phase 1, the project members met to develop a shared understanding of the common object, a shared field guide and fundamental theoretical and methodological issues, particularly in relation to the data gathering.
- In phase 2, the empirical data was gathered. Together with the initial national analyses (based on the common set of analytical tool, but not necessarily a common set of theoretical perspectives) five reports specific to the national analyses were produced. These five national reports are now available either online at www.upgem.dk or as printed books under the titles: *Full Collection of National Reports* and *Draw the Line! Universities as workplaces for male and female researchers in Europe.*
- In phase 3 the research work has largely been conducted by the team in Denmark which has drawn on the work of the rest of the project members. The Danish team was also receptive to both the feedback and discussions with the research assistants; especially concerning the research assistants views of the culture contrast analyses of issues performed by the Danish team. This publication *Break the Pattern! A critical enquiry into three scientific workplace cultures: Hercules, Caretakers and Worker Bees* (also available both online and as printed book), differs from the previous work in UPGEM by drawing on a data base compiled from interviews from all the partner countries. In all, this data base includes 208 interviews translated into English. Each one is coded with 34 codes agreed on at the seminar in Estonia 2006.[6] *Break the Pattern!* presents the result of the new culture contrast method.

[6] See *Draw the Line!* for a description of the data gathering and the codes used for the ATLAS.ti analyses. 239 interviews have been gathered in all in

In addition to the above mentioned publications, we have published our quantitative research and discussions with research colleagues, scientists and policy makers in a collection of papers from an international conference held in Denmark, May 2008, where we presented UPGEM results and discussed their implications in relation to the wider field of studies of gender and science. These findings, discussions and papers can also be found online at our homepage and in the book *Draw the Line! International Conference, Copenhagen 2008. Papers, proceedings and recommendations*.

2.1 Building up a common objective in phase 1

The UPGEM partner professor Yrjö Engeström has underlined that from the perspective of activity theory an action is perceived as connected to an activity system driven by a shared motive.

> In activity theory, the distinction between short-lived goal-directed action and durable, object-oriented activity is of central importance. A historically evolving collective activity system, seen in its network relations to other activity systems, is taken as the prime unit of analysis. Goal-directed actions, as well as automatic operations, are relatively independent but subordinate units of analysis, eventually understandable only when interpreted against the background of entire activity systems. Activity systems realise and reproduce themselves by generating actions and operations. (...) A collective activity system is driven by a deeply communal motive. The motive is embedded in the object of the activity.
> (Engeström 2000, 964)

UPGEM (Hasse, Sinding and Trentemøller 2008a, 381). In line with the systematic set up in the project design we have selected 208 interviews to ensure as even as possible a representation of male and females, stayers and leavers in each country for the analytical field for *Break the Pattern!*

An activity system is constituted by relationships between subjects, divisions of labour and rules (implicit or explicit) in a community. The community uses artefacts (tools or instruments) to strive for the object of the activity which leads to some kind of output (Engeström 1987, 78).

In the context of physics, the direction of human activity can be described as a shared object (e.g. conducting physics research), which motivates a collective of people (e.g. physicists) to produce some kind of outcome (e.g. physics research results). The notion of a shared motive has guided the work in UPGEM in the way theory in social science normally guides and shapes data material. It has also affected the way we have come to understand ourselves as researchers.

Already in 2004, the six partners began to communicate about the project and decided on the research design and the theoretical framework. In 2005 the partners began the planning of the six week long Innovation Seminar. The aim was to create a shared object in the project. In January 2006, the eight UPGEM research assistants met in Copenhagen to develop the project together with the partners, who took turns in visiting, presenting and discussing their views on issues of relevance to the project.

The ideology behind the Innovation Seminar was that a shared understanding of project relevant issues would make us better equipped to develop a common field guide for the research project. We would also be more capable of discussing data and analyses with each other once the day-to-day work of the project began in the home countries. The practical goals of the seminar were therefore:

- To develop an interview and field guide for the research project as well as a survey questionnaire.
- To gain a shared understanding of thematic, practical, methodological and theoretical issues in the project.
- To work with the central concepts in the project – i.e. gender, stayer/leaver, physics, activity and culture.
- To share knowledge of practical tools (Endnote, Share Point, ATLAS.ti etc.).

The actual research work in the field was to be carried out, according to the field guide, through a division of labour in which the research

assistants interviewed physicists, conducted fieldwork and performed analyses of national data under the guidance of the partners in the project. Yet, to be able to conduct collaborative research that integrates research assistants and partners, with a broad diversity of academic training,[7] the partners deemed it crucial to ensure a fully communal motive and a shared understanding of the analytical tools used in the project. For that reason the project design also involved a number of seminars (in addition to the Innovation Seminar) at which research assistants and partners have met to learn from each other and work together. These successive seminars have typically been of two weeks duration in each partner country throughout the project[8]. For the success of the overall research design, the seminars, and the collaboration in general, were thought to serve two purposes.

The first aim was to create a shared object by developing a shared understanding and agreement of the employed methodology and a shared knowledge of the fundamental concepts and analytical tools employed in the individual analyses presented in the national reports. The second, and later, aim was to explore and discuss in detail the culture contrasts in our research material. Though the latter did not serve as a direct aim in the first phase of the project, it has naturally been explored all way through the project, which is inevitable when so many people enter into a truly close collaboration.

During the Innovation Seminar in Denmark we developed the final interview guide. Before the seminar, the research assistants had conducted a test interview based on a preliminary interview guide. The outcome of this preliminary work formed the point of departure for the

[7] The academic backgrounds ranged from anthropology, philosophy, social psychology, pedagogy, theology, sociology to linguistics.

[8] Partners and research assistants met and worked together at the Innovation Seminar in Copenhagen (09.01 – 17.02.2006), for a conference and work meeting in Poland (04.09 – 05.09.2006), at the Mid-term Seminar in Estonia (27.11 – 08.12.2006), at an ATLAS.ti workshop in Copenhagen (21.02 – 22.02.2007), at the second Mid-term Seminar in Finland (08.07 – 20.07.2007), and for two Culture Contrast seminars in Italy (15.11 – 25.11.2007+ 20.04 - 30.04.2008).

final interview guide.[9] Both the field guide and the interview guide were formulated in collaboration in English but were translated into the local languages when used in the local national contexts. To be able to decode the deeper levels of self-evident meaning in the spoken words, it was decided to conduct the interviews in the local languages and then translate these into English. To have English as the working language in the project was necessary for the shared discussions of data and the cross cultural analysis that was built into the project design. In the discussion of theoretical concepts and formulations for the interview guide we, as researchers, already explored our own learned connections or self-evident meaning ascription.

At the Innovation Seminar, we discussed the five concepts – *gender, stayer/leaver, physics, activity* and *culture* – that were basic to the data gathering including other methodological issues relevant in the first phase of the project. For the purpose of gathering data, the category of gender was simply defined on biology (sex) as 'male' and 'female'. In the analytical work, this definition was unfolded in its cultural and social dimensions (gender). The UPGEM research assistants had experience of working with a range of different gender theories from a performative gender theoretical approach to a more standpoint theory informed framework (e.g. Gilligan 1977; Chodorow 1978; Keller 1985; Harding 1986; Rubin 1975; Gherardi 1995; Scott 1999; Judith Butler 1990; 1993; 2004 and Rosi Braidotti 2002). We decided that for the analyses in the national reports each partner group was entitled to make use of the gender theory it saw was a best fit for the national data. See for instance the Finnish National Report for a discussion of gender as a set of social processes (Vainio 2008, 219), or the Italian National Report for theories of gender at structural and interpersonal levels (Ajello, Belardi and Calafiore 2008, 271-273).

For the present publication the culture contrast method has centered the analytical focus on the juxtaposition of some of the elements in our culture contrast model (i.e. male/female and culture) and our informants' connections between issues such as competition, family, power

[9] The process of developing the interview guide is described in detail in *Draw the Line!*

relations, organisation of work etc. We have not let specific gender theories guide our research but tried to let the empirical data guide our discussions of gender. In other words, we have analysed the meaning of gender through the role it has been given by our informants in their connections, which in turn generate cultural models for appropriate members of the physics activity. In the last chapter we unfold and discuss the meaning of gender in relation to the cultural models identified in physics *in* culture and in relation to the ideal type cultures identified in physics *as* culture.

By including what we call 'leavers' in the empirical data material, UPGEM adds a hitherto unexplored dimension to the understanding of gendered career paths in academia. The specific reasons for leaving are discussed in the five national reports. Stayers and leavers refer, respectively, to present and past scientists in physics in academia. By conducting interviews with leavers who have left physics research in academia in their home countries, the project obtains a unique insight into the local context from an external retrospective perspective. Indeed, approximately half of our informants look back on their career in academia from their present position as outsiders. Our broad definition of a leaver is a physicist who has begun or finished a Ph.D. in physics but who has left physics research in academia in their home country. A stayer is defined as a scientist who has begun or finished a Ph.D. (or the equivalent) in physics.

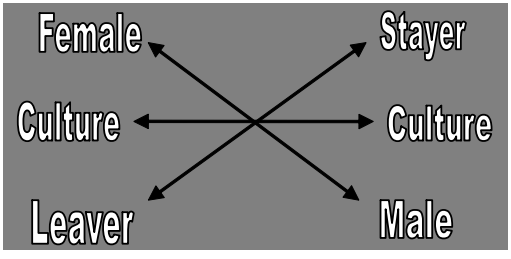
Physics was defined as any kind of physics research conducted at university institutes for physics. Though we were well aware that physics research is conducted under many different institutional settings, we chose this definition to ensure some degree of comparability in the project and to ensure insight into universities as workplaces in the different national contexts. Based on Engeström's work, we analyze these workplaces as activity systems.

UPGEM is a study in which the researchers almost study themselves; like our informants we are researchers conducting research. Moreover, the conditions of the physicists' research context can in many ways be applied to our contextual conditions as researchers and researchers in academia in general. To avoid confusion, however, we shall in this publication refer to ourselves as 'researchers' or 'research

assistants' while the physicists are referred to as either informants, physicists or scientists.

In our early analyses and discussions in the project we used the model presented in Figure I as a simple illustration of the patterns of complexity inherent in the project design:

Figure I *Model for culture contrast analysis of fundamental etic categories in UPGEM*



In phases 1 and 2 of the project, the research mainly centred on the complexities and contrasts of female/male and stayer/leaver, and less on the contrast of culture, as is evident when reading the national reports. For the national reports, the partners and assistants have made individual local interpretations and analyses of the local data based on the shared tools for analysis. However, unlike the interpretations and analyses behind *Break the Pattern!* the national reports have not employed the culture contrast method.

In the initial phase of discussing methodological issues, it was decided to explore and develop collaboratively the theoretical concepts of activity and culture as the project proceeded. In our description of phase 3, we present what we found to be useful definitions in this connection and in how we have employed these definitions in the culture contrast model.

2.2 Conducting interviews and discovering self-evident meanings in phase 2

In phase 2, the project, partner and research assistants continued the work in the respective partner countries based on the understanding of the shared object. All the research assistants followed the developed field guide and interview guide.

The data has been gathered through participant observation at physics institutes and in-depth interviews with male and female physicists. At least 36 were conducted in the smaller (by population) countries and at least 50 in the two bigger (by population) countries.[10] To secure anonymity, especially in Estonia and Denmark, it was decided to conduct research at a minimum of two and preferably more universities in each country. Even though the UPGEM project has limited its research empirically to physicists who are or have been engaged in physics research at university institutes in the five partner countries, the diversity of the empirical material is extensive.

To uphold the shared understanding and secure uniformity in the data gathering, the research assistants provided monthly updates, via our so-called SOA-letters[11] and Skype meetings, on the progress of the research programme through a coordinated exchange of information. Moreover, after having been coded and sorted nationally in ATLAS.ti, using a shared system, the interview transcriptions were compiled into one database for the culture contrast analysis presented in this publication. In this manner, the project secured rich qualitative empirical material which could be contrasted continuously at the seminars.

Studies of people's everyday life activities often employ interviews as well as participant observation to generate a thorough understanding

[10] The disparity in the number of interviews is due to the different population size of the countries. 36 interviews in Estonia equates to about a third of all the physicists in the country, but much less than a tenth in Italy. To ensure enough data material to discuss national differences, we calculated that the two 'bigger population' UPGEM countries (Italy and Poland) should conduct an extra 14 interviews.

[11] SOA-letters is the acronym for 'State of the Art'-letters.

of people's everyday life and their perception of their life. As a method of gathering empirical data, UPGEM primarily relies on the interview – a language based approach, which is probably the "most widely used method of investigating the social world" (Aull Davies 1999, 94). Ethnographic interviews share features with everyday conversations because the researchers enquire about the informants' life in relatively informal phrases with follow-up questions and genuine curiosity. Certain elements do, however, differ from a normal conversation. Firstly, in UPGEM, the research assistants based their questions on the prefabricated interview guide. Following this approach, salient research themes were chosen before the interview situation (Kvale 1994) and the semi structured flow of questions ensure the possibility of discussing and contrasting the research material on the basis of, among other things, nationality. Secondly, the fact that an interview is an enquiry leads to an uneven distribution of turn-taking and speaking time for questions and answers respectively. It is the task of the researcher to make the informant feel comfortable answering the prefabricated questions and, if necessary, repeat or re-formulate the questions.

The intention of the close collaboration and the similarity in the type and amount of work conducted in each partner country was also to achieve a high degree of transparency in the research procedures. Transparency is crucial because the project investigates not only the meaning of culture and gender (embedded in cultural meaning) but also the relationship of the collected data across the national cultures in the project. Because the project design ensured a high degree of transparency in the work procedures (what work to be done by whom and how), we were able to get insight into and be surprised by each other's research culture and research results. The purpose of this insight was indeed to be surprised and to challenge our own and each other's assumptions and cultural self-evident meaning ascription.

Another outcome of the high degree of transparency is an early awareness that the data and the research process are marked by national (as much as individual) differences. Prime examples are how strictly the interview guide is followed or whether the researchers, at the expense of an interview guide thematic allows themselves to ask new questions to catch unforeseen details and get more sensitive or detailed

answers. In the interview phase the Danish researchers and their informants found for instance religion to be almost irrelevant to physics in Denmark, contrary to sexual harassment, so the researchers rarely probed deeper into religious issues. The Polish and especially the Italian researchers and their informants are, however, much more interested in scrutinizing the issue of religion (for a description of different cultural models for religion in the Protestant and Catholic UPGEM countries, see Chapter 3).

During the research period, we developed an understanding of the activity of physics in our own national environments and of our own activity as researchers. We found that some of the methodological issues, which concerned our national culturally informed activity as researchers, also had relevance for our analysis of physics activities and the question of inclusion or exclusion of especially female scientists from these activities. Though we *did* to a very high degree come to share an understanding of the importance of the questions asked, the transparency of our collaboration made it possible to shed light on some basic conditions, which we believe implicitly guide most international research collaborations.

2.2.1 Language in cultural activity

Because we worked so closely together across national borders it soon became clear that to develop a shared motive in research you have to begin by creating a shared vocabulary. We shared understandings of academic research, the object of the research and the scope of the research process. But as it is to be expected in international projects involving researchers with different educational backgrounds, we differed in relation to knowledge about qualitative methods and theoretical understandings of our *a priori* categories. To our surprise, however, meaning of what all of us considered to be everyday concepts (in our everyday communication in English) differed.

The first analysis of the test interviews at the Copenhagen Innovation Seminar it became clear that we did not ascribe identical meaning to the everyday words we used in the discussions. It gradually

became clearer that diversity not only stemmed from different theoretical positions and experiences with fieldwork (though these differences also played a role), but from deeply embedded national understandings of possible *connections*. Consequently, the words and formulations in our interview guide appeared to carry different meanings and connotations according to the researcher's national background. In the UPGEM project, the aspect of learning a new vocabulary in activity became evident when the researchers contrasted the answers from the shared interview guide and realized that the semantic content (or emic meaning) of a number of words (employed as etic categories) differed from country to country.

In UPGEM, we have taken a number of terms as our starting point for the research process and used them as etic categories, defined by Kenneth Pike (1967). The notion of *etic* and *emic* derives from the terms *phonetic* and *phonemic*, respectively. Phonetics relates to the overall sound system of a language and the individual sounds made in a spoken language, but does not deal with the inherent meaning of these words. In this way etic categories can be defined as the researcher's *a priori* categorisations (ibid.). A phoneme is the theoretical definition of the smallest distinctive sound in the sound system of a language. It carries no meaning by itself, but in contrast with other phonemes it can change the meaning of a word, as in the case of *culture – vulture*. To understand the meaning as well as the changed meaning created by the phoneme you need to be acquainted with the everyday context in which the vocabulary of the language is formed. In anthropological analysis, emic categories refer to the categories or meaning which the informants consider important, i.e. emic categories represent the insiders' perspective.

The aim of cultural historical research is not to have these (theoretically constructed) etic categorizations confirmed; just as the aim of our research has not been to find and pin down the physicists' activity system or confirm a particular gender theory. Our theoretical framework constitutes the starting point of a research process which, if performed thoroughly and systematically, will lead (over time) to a deeper insight into the locally formed emic categories including the complex connections made between meaning, word and actions in activity. To give an example; when the UPGEM researchers presented

the concept of family, as it was described by the informants in the interview situations (and in most cases accepted as a self-evident by the researchers), a contrast in the semantic content of the word emerged. In the Italian context, *family* covers mother, father, children, grandparents, siblings, uncles and aunts etc. whereas in the Nordic context (Finland, Denmark and Estonia) *family* only covers mother, father, their children and possibly grandparents. By contrasting and discussing each other's research, it became clear that the etic category *family* carries different emic meanings (self-evident meaning). The contrast in the emic meanings can be summed up as the 'extended family network' versus the 'nuclear family'. As we will show in Chapter 3, the realisation that the concept of family carries different emic meanings has been essential for the analytical field.

The word *hierarchy* is another example of the surprise which challenged the researchers' assumption of shared categorizations. We assumed hierarchy to be a common word in all our languages with a relatively common denotative meaning and relatively few connotations. Consequently, we expected to share immediate understanding of the word with our informants and fellow researcher. However, in the interview situation (where the researchers asked into the unknown world of physics) a number of situations arose where the concept of hierarchy was seemingly not shared but must be explained by the interviewer.[12]

[12] Instead of listing the informants' real name we have given them Physicist numbers (P-numbers). The P-number system employed in this publication is not identical to the system employed in the national reports. We list the informants' gender (M = male, F = female) and nationality (DK = Danish, EST = Estonian, FI = Finnish, IT = Italian and PL= Polish). In some cases, the quotes are very close to constituting personal stories and accounts from physics *as* culture. To protect the individual physicists from being recognized by colleagues, we have given them fictitious names when we judge their life story statements will be recognizable. When statements are also quoted in either of the national reports we have omitted the P-number to avoid the confusion of operating with two different P-numbers for one physicist. For the sake of the analysis we have also omitted the nationality of our informants in Chapter 4–6 on scientific ideal type cultures.

Interviewer: *How's the hierarchy here at this working place?*
P14, F, DK: *What do you mean by that?*
Interviewer: *Who decides what and why for instance?*
P14, F, DK: *I've got my own money so I'm not subject to anyone, but I don't have my own equipment so therefore I'm subject to them (...).*

As this example illustrates, the researchers learn about the emic categories from the informants. Such new insights that are gradually learned as the researchers learn from the physicists' answers have enabled the researchers to ask more sensitive question, which has added richness to our analysis. The exchange of words quoted above shows that even though the researcher and informant share some cultural self-evident notions of the lexical dimension of the word *hierarchy*, they do not share the cultural local (emic) meaning. Therefore the researcher must explain the connections she imagines relevant for an understanding of the concept of hierarchy to make the informant understand and answer the question. As mentioned, it turned out that even within the group of UPGEM researchers the term carried different connotations and triggered different associations of possible connections which became clear when it was discussed in relation to its workings in our respective academic structures.

These and many similar discussions have formed the basis of our seminars in the project, and it is from these discussions we have gradually come to share an object of the research activity, though we must also admit that it never became a completely shared activity. Contrary to some of the many activity systems discussed by Yrjö Engeström and his associates at University of Helsinki (Hasu 2000; Saari 2003;

Regarding the quotations; if we have cut out words or sentences it is marked with three dots in parentheses (…). If we have taken out names of people or places we have written our replacement in square brackets e.g. [my colleague]. In some places we have also found it necessary to recount a longer and not always linear story in our own words also [in square brackets].

Seppänen 2000; 2002), our activity was too loosely held together to overcome all communication problems and create a common motive.[13]

2.2.2 Analytical and empirical fields

By telling about important issues of their everyday life, the physicists have drawn lines for us and made connections which we could not have imagined as psychologists, philosophers, anthropologists or linguists. We consider these interviews *life* stories rather than life *stories* – that is, rather than focussing on the narrative structure of the story, we look at the stories as providing access to the physicists' life experiences (Peacock and Holland 1993) and especially the connections made in their statements. The reader may notice that some P numbers recur throughout the analysis and thereby assume that we have largely built our analysis on statements from these scientists. Therefore, we find it important to note that some scientists are more eloquent than others wherefore we have used statements from these scientists to illustrate attitudes or actions many or our informants have described. Though our questions have in part constructed our research material, the research material has also grown when we as researchers have learned from listening to and studying the physicists' life stories. It is, however, not a complete co-construction as we have undergone a long and continuous learning process whereas the individual physicists only learn from our questions in one interview. The research material and the analyses that are presented in the first UPGEM publication, *Draw the Line!,* are formed by the UPGEM researchers' diverse disciplinary backgrounds and the different theoretical frameworks inherent in these disciplinary traditions. In spite of our varied backgrounds and different national contexts, we have been able to discuss the empirical material as a group working together over time and in this complex process been able to learn from the diversities of the physicists' life stories.

[13] The lack of a shared motive can also be used to explain why our Polish partner, Professor Elzbieta Oleksy, left the project immediately after the local research was conducted in Poland in December 2007.

Theory shepherds research in particular directions, and our theoretical perspectives have to some extent constructed the research field for us. Yet, we have learned more than our own constructions can account for, as we have been open for surprises coming to us from the empirical field. For that reason, we find it useful to distinguish between the empirical and the analytical field. Though the analytical field (formed by theory and empirical data) overlaps with the empirical field, the opposite is not the case. In humanistic research[14], the term 'empirical field' does not cover *all* there is to be found in a human world, but all that the research design *could* have found. The phrase 'the analytical field' covers what was actually found within the research outline and used in the analytical text. By making this distinction, we remind ourselves that the empirical field is always potentially wider than the actualised analytical field.

If the analytical field covers as much as possible of the empirical field we can refer to the strength of research of an activity. If, however, the research only covers a small part of the empirical field we refer to weak research as it may offer a skewed picture of what it was possible to understand of the informants' activity. An analytical field develops to some extent on the basis of the theoretical framework. Though the cultural historical activity theoretical approach can be seen within the wider field of social constructivism, we have found that constructivism is not only relative to the theoretical framework but also the analytical field. We can also refer to strong and weak analytical constructions of the everyday life (also referred to as activities), which our informants share.[15] By constantly contrasting each other's research (i.e. the empirical field as well as the analytical field) in the project, we have been

[14] Research which has humans as the research object rather than organic and inorganic matters with which the natural sciences typically deal.

[15] The type of cultural historical framework we build upon extends itself to activity, culture psychology, social practice theory and cognitive anthropology. Each subfield in this wider framework, which we define as cultural historical activity theory, employ slightly different wordings to refer to the same empirical phenomenon of people working together – e.g. activity (see Engeström 1987; 1996; 2000), community of practice (Lave and Wenger 1991) and figured worlds (Holland, Lachicotte, Skinner and Cain 1998).

able to call forth many new perspectives, which would otherwise have gone unnoticed. Furthermore, if the process of culture contrast is successful, the researchers learn about the tacit and self-evident meanings in the empirical field. Consequently, the analytical field of the activity system will gradually emerge and take form. If the researcher and informants share some degree of common ground (within the empirical field), it takes an outside perspective to identify how the culturally informed self-evident meaning or connections form us, as researchers, in our activity. In the same way as we have come across cultural historically formed self-evident meanings that were shared nationally, we must contemplate whether some self-evident meanings in the researcher group have not been called forth, or have self-evidently been given precedence, because the UPGEM team has a majority of female researchers. It is possible that this is partly why we have found the issue of sexual harassment important to take up. In that respect, our gender may have influenced our gathering of empirical data and our interpretation of these (Callaway 1995, 29) and we note with Donna Haraway (1991) that a researcher's knowledge is always situated knowledge.

2.2.3 Methodological position

Our approach is a mix between a social constructivist and a critical realist approach (Aull Davies 1999). On the one hand, we acknowledge that our (diverse) theoretical background will form the analytical categories we operate from and within. On the other hand, we also acknowledge that our research questions and the themes we have built our research guide around are embedded in a field of politics. Therefore, our research results will be read and interpreted by research colleagues and politicians, who will interpret our work according to their ethic standards, norms and expectations. Knowledge is neither objective nor neutral and can only be truly emancipatory (as believed in the Marxist tradition) if power relations are taken into consideration (Foucault 1982).

Even though we do not discuss power relations as such, they are apparent in our very framework of analysis. We assume that in commu-

nities of activity, participants have learned what the researcher will immediately define as "self-evident meaning" (Hasse 2002, 117). We also assume that researchers do not know all the self-evident connections made in the studied community but will learn about the differences between themselves and the informants' cultural self-evidence as they emerge in the interview situation and in the research process. In this perspective, the interview situation is not an isolated event. As the informant expresses previous experiences and as the researcher becomes more experienced in interpreting these statements, a diachronic perspective appears which offers insight into the dynamic cultural context.

We acknowledge that researchers are human beings which will influence our research process and the analysis phenomenologically; we have emotions and physical bodies with limited access to the physical and social space of our empirical field. In a post-phenomenological sense, bodily movements can be argued to be cultural (Ihde 1995). According to our own theoretical approach we cannot escape these conditions. Being a social constructivist is therefore not so much a chosen position as a condition for any theory of science – including the positivistic. We are neither logocentric nor believe that only reason guides our work. We do not expect any pure description of a community of practitioners of physics to be possible. Furthermore, we acknowledge that the life world studied in UPGEM is to some extent constructed by the analytical lines drawn by the researchers.

We also acknowledge that we are constructive in our presentation of the research results because we add new perspectives and conceptualisations to the social life worlds of the informants – but also to the social life worlds of the researchers. To create strong research, the researcher must learn the meaning of words in the given local context, a meaning which is already known by the informants. In this sense, informants constitute a social world of emic meaning learned through everyday life practices, which can be explored by researchers.

We are critical realists in the sense that we do not accept that research is determined by the analytical categorizations put up by researchers, nor that our research results are constructions made solely by us as researchers. We argue for the existence of a social world of

emic meaning to be discovered by researchers. Good research is when the many subtleties and complexities of this social world are uncovered. So, we discard the sense of relativism in research that anything goes and that any conflicts about the validity of research can be solved with a reference to 'just another point of view'. When we try to unfold the activities inherent in the research material we are dealing with immensely complicated matters and we must accept the limits of the activities and the fact that a researcher's own (assumed and often theoretically formed) emic and etic categorisations can be more or less relevant for the understanding of what is at stake in the activities. As the aim of our research is to generate general science (basic knowledge of studies) of gendered human beings, our analysis must always aim at saying something more than what is of interest only for the particular informants' community.

We assume that the problems of researchers not attaching the same meaning to words and the problems of building shared objects in international research activity are not only a problem for the UPGEM project. The problematic was, however, more easily drawn to our attention in this project because we spent so much time discussing the research.

Our analysis and the physicists' activity can be perceived as evolving activity systems, which are embedded in national cultural contexts. The effects of the national cultural context can be brought to the fore through the method of culture contrast. As a result, our model of analysis must consider two aspects:

A. The different connections made by researchers and informants gradually come together in the researchers' learning process, but can never be fully overlapping as researchers stay in *their* research activity and informants (here physicists) in *their* research activity.
B. The different connections the researchers make of their national backgrounds; disciplinary 'upbringing' and personal semantic networks all play a part in the production of data and the understanding of the subsequent analysis. The UPGEM research process has moved the researchers closer towards a common object. With more possibilities to engage in the same activity together, we would have been able to learn even more from each other.

In cultural historical activity theory, the framework is often used as the analytical lens, which might guide the design of the project but which is rarely used on the team of researchers themselves. In that sense, the theory is a frame for conducting research in what is considered the *informants'* activities rather than a tool for building up *research* as a new shared activity. In our case, however, theory, methodology and methods conflate. The questions which have emerged concerning physicists' activities can also be directed at our own research activity. Rather than despairing over the problems of conducting research in different national cultural contexts and the difficulty of developing a shared object, we began to see it as an advantage to be explored in the project through the method of culture contrast.

We asked ourselves, how we can turn these new complex comprehensions of what it takes to create a shared activity with a common object into use in our analysis of inclusion and exclusions from the physicists' activity.

2.3 Employing the method of culture contrast in phase 3

The method of culture contrast is based on cultural and psychological theory. Within this theoretical frame we form self-evident connections which make us perceive the world in self-evident ways. This approach has formerly been discussed by Hasse (2002) as "cultural learning processes" and in relation to differences found between the educational system in Italy and Denmark (Hasse 2005; 2008) as well as in relation to the use of culture contrast as methodology in international research projects (Hasse and Trentemøller forthcoming).

One aspect of learning processes is that we learn new things by contrasting the new with what we take for granted. This type of learning and acquiring new knowledge is often an unreflected process. Laura Nader has, to name one of many terms for this process, defined is as 'implicit comparisons' (Nader 1994). In our understanding of the research process, these implicit comparisons (which build on already formed self-evident connections of meaning) can be used constructively

if the informants' statements are allowed to challenge the researchers' assumptions about unquestioned connections. If researchers allow themselves to be challenged, new connections may be formed. In this way, the unquestioned learning process becomes reflected. Moreover, if the researcher explores the change of self-evidence in this process, new understandings of local organisations of meaning can also be formed (Holland 1992).

A researcher's often implicit comparison in the field and in the analysis can also be made explicit by making a track-record of what challenges the underlying assumptions of the researchers' comprehension and hypotheses as the researchers learn (together with their informants) to attribute new meaning to e.g. physical space and otherwise common sense words (Hasse 2002, 122). It is, however, a very slow and complex process of reflection, which is almost impossible to use as a starting point in large projects like UPGEM. From our research in the physicists' community and from our own cultural learning process we can imagine that many national self-evident meanings in activities go unnoticed in cross-cultural research if they are not challenged explicitly in a culture contrast analysis.

In a big project with multi-sited ethnography (Marcus 1995) a shortcut to a deeper cultural understanding can be to contrast, for example, interview material from one context with interview material (based on the same interview guide) from another but similar context (e.g. physics institutes from two different European countries). By using the culture contrast method in this way, new self-evident connections (which might otherwise not be noticed by the researcher) can be revealed.

For the analysis behind this publication, we have made use of the methodology of culture contrast in so far as we have first explicitly tried to challenge our assumptions by contrasting these with the assumptions of the other UPGEM researchers and vice versa. Secondly, we have challenged our assumptions by contrasting these with the connections of our informants. The purpose of the culture contrast method is not to compare *a priori* categorisations such as 'men' and 'women' – but to contrast the informants' (and the researchers') connections that attach particular meaning to words and actions in a local national context. Thus, we do not simply compare words and

essentialities but possible connections. In traditional cross-cultural comparison, the *a priori* categories typically act as the third body which is to be compared in two contexts. In our culture contrast analysis, we have not selected pre-defined *a priori* categories as representatives for cultural difference. Instead we perceive culture as what appears to be connected in one context but is (more or less) absent or different in another. In this context, looking for the absence of particular connections is just as valid an analytical approach as looking for the presence of a particular connection.

In line with our theoretical framework of cultural historical activity, we do not focus on our informants' individual life stories in science but on the "collective voice" which emerges in the analysis of the empirical data (Hasse, Sinding and Trentemøller 2008b, 30–31). When we look for connections formed in activity, the analysis of such processes must not be confined to individual statements or individual practical actions but must involve the wider context that direct human actions – human activity.

Systems of activity develop as dynamic relations between people, groups of people and their use and creation of artefacts (such as detectors, computers and symbolic signs) in material ecologies. The activity system also involves implicit or explicit rules for the use of the artefacts, rules for human and material interaction as well as rules for specific distributions of knowledge and tasks. The entire system of activity is formed by particular cultural historical processes and can be seen as a specification of the term *context* (Engeström 1993, 67). Activity systems can be used as tools of analysis in which focus is on how context influences people's possibilities for manoeuvring. As an analytical tool, activity systems also make it possible to connect what people say they do, with a wider understanding of the context, in which the enunciations are made.

Activities are closely connected to cultural historical developments. Consequently, the available identities connected to activities must also be culturally mediated, and this leads to cultural differences in how the perception of other human beings and social relations are mediated. This perspective has implications for our methodological understanding of how to study the relationship between activities and culture. Cultural historical theory argues that the meanings of words are formed in

human activity, or in other words, meaning is built into 'artefacts' (words, in the context of the UPGEM project) during the activity. When we, like Engeström, say that activity is context (ibid.) we argue that the meaning, the thoughts, the feelings and the motivation behind the words we speak and hear are understood because we have lived the words simultaneously with the activity. Vygotsky, the main inspiration behind cultural historical theory, describes it as follows:

> Understanding the words of others also requires understanding their thoughts. And even this is incomplete without understanding their motives or why they expressed their thoughts. In precisely this sense we complete the psychological analysis of any expression only when we reveal the most secret internal plane of verbal thinking – its motivation.
> (Vygotsky 1987, 283)

Through iterative encounters with informants, with whom the researcher gradually comes to share the activity under study, the researcher forms an understanding of the local meaning, thoughts, motivations and feelings ascribed to the spoken words. Over time, this new understanding may challenge the researcher's self-evident ascription of meaning to the spoken words. By pointing to the time perspective of the research process, culture becomes dynamic (Hasse 2002). The crucial aspect of a successful, good research process is that the researcher can to some extent conduct research on the same *rationes decidendi* as the informants.

For the researcher (who is like a newcomer) who has not been part of the local process of building meaning into artefacts in the activity system, the meaning of the physical sound waves (i.e. the words) cannot be taken for granted but must be learned gradually (ibid., 120). What makes this process very complicated is that cultural self-evident meaning is rarely reflected upon. Therefore it is an ever present risk that the researcher's already formed connections (in etic or emic categories) rather than the informants' connections come to guide the analytical construction. Thus, we do not define the concept of culture as

solely an analytical category but something which is specific for the time and place of the conducted research.

When the focus of the research is on why some leave and others stay in the activity (in our case physics research at universities) it is crucial to analyze how the activity both gives direction for stayers and creates leavers. It is also crucial to analyse why particular types of leavers develop in the activity in one context of national cultural historical processes but not in another, if the activity of physics is a global activity free of national influences. That leads us to the question of why we find national differences in the relative proportion of male and female physicists within the physicists' activity system, if all physicists share the same object and motive (i.e. to conduct physics research). Why are women seemingly more accepted in the physics activity in Italy compared to Estonia or Denmark? To find the answer, we must understand the social dynamics in workplace activities and understand how processes of inclusion and exclusion are connected to national and professional cultural historical developments. We believe the processes behind the self-evident patterns of selection mechanisms are best explained by looking for clusters of connections formed in the activity. We are aware that it is an extensive task to identify such self-evident patterns, when we as academics may share some of the self-evident connections our informants make.

2.3.1 Connectivity

One of the first methodological questions we addressed in the UPGEM project was how to study culture as it evolves in activity. In our research, nationality does not equal culture *per se* even though the notion of national culture is used as an axis for contrasting. In the research work for this publication, culture is found in the connections we have learned in practical activity and self-evidently form our understanding of words, actions and lack of actions as well as appearance and lack of appearance in an activity. Connections and clusters of connections are not confined to activities in national settings. The scope also includes the often un-

questioned background for inclusion and exclusions of subjects from activities.

To gain a better understanding of the clusters of connections, we have made use of the theory of cultural models as an analytical tool to supplement the activity theory. It should be mentioned, however, that the two theoretical frameworks (cultural historical activity theory and cultural models) are normally not thought of as supplementing each other. Thus, working with the two as a combined theoretical perspective is a new approach. When self-evident connections are identified, the analysis may find a network or cluster of connections, which can be described as cultural models. The notion of cultural models was developed by a group of American anthropologists and was introduced for the first time in the anthology *Cultural Models in Language and Thought* (Holland and Quinn 1987a). Here it is described as "[c]ultural knowledge that appears to be organized in sequences of prototypical events – schemas that we call cultural models" (Holland and Quinn 1987b, vii). In line with this framework of thought, we can say that the semantic meaning of categories is learned through participation in everyday activities and categories are connected in cultural models. When we learn the meaning connected to the phonetic and lexical dimensions of words, the culturally selected knowledge is connected to standardized and therefore recognizable events and conceptualisations. These conceptualisations tell us that, for example, a wedding contains a standardized 'narrative' that connects prototypical events (like going up the church aisle), prototypical roles for actors (e.g. priest, bride and groom) and prototypical artefacts (e.g. a bouquet and rings). The standardized connections can evoke entire worlds in which the artefacts are put to use; actors act and events unfold in simplified and expectable ways (ibid., 20).

A network of connections can be called cultural models, and cultural models form and ascribe feelings and motivations to the spoken words and actions. When these sound waves reach the researchers expectable connections are evoked. So, networks of connections come to constitute the frame of interpretation, and it is through interpretation that an empirical field becomes an analytical field. Cultural models are analytical constructions formed by us, the researchers, but the models have grown out of a meeting with the social world, and in this world the

cultural models guide the informants in their activity. For the researcher to be able to reach an understanding of the social world of the informants, she must focus more on uncovering the local network of connections than focussing on the actual spoken words. Because people learn to connect the general prototypical scripts with personal semantic networks from their own life experience (Strauss 1992, 211), cultural models can carry different meaning for different informants. In the framework of Strauss, the basic constituents of scripts are called schemas in which parts relate to the whole in "a patterned fashion". Schemas can act as selection mechanisms in so far that they "specify how essential elements relate to one another" and when cultural schemas are inter-subjectively shared they can be referred to as cultural models (Holland and Cole 1995, 478–479).

Some of the clusters of connections identified in the UPGEM research constitute cultural models which are formed in national cultural historical learning processes. These cultural models give rise to national self-evident assumptions, for example, about educational entry requirements to physics in academia and conceptions of family. In this publication, we argue that activities embedded in national cultural histories also create particular national connections, which become self-evident over time as they ascribe particular meanings to words and actions in the activities. Such nationally formed connections are formed outside of the activity of physics, but may influence those who are perceived to be self-evident members of the activity in the national context. In this respect, cultural models can explain why women in some countries do not consider becoming part of the physicists' activity system, whereas in other countries this is an option among others for women.

2.3.2 Clusters of cultural models forming ideal type cultures

In order to better understand how the inclusion and exclusion mechanisms in the physics activity system work we have found it necessary to take the framework of cultural models a step further. We have expanded the notion of cultural models to include not only local

national cultural models but also overarching clusters of cultural models within physics *as* culture. We refer to these clusters of cultural models as 'ideal type scientific cultures'[16] or ideal type physicists. The ideal types are analytical tools formed by the informants' description of their social (and professional) world at physics departments in the five UPGEM countries. We can use these tools to illustrate different perceptions of ideal actions in the physicists' activity.

At the base of the scientific cultures we find certain clusters of cultural models which can have a reinforcing impact on each other in the system of activity. That will give more importance to certain clusters of cultural models over time. This process forms cohesive cultural patterns for tacit negotiations of inclusion and exclusion of members in the activity. It is in the contrast of the clusters of cultural models inherent to the ideal types that the salient patterns of different evaluations of subjects emerge. In this way activity, culture and connectivity inform each other. Thus, by contrasting we can identify why some but not others are excluded from the activity systems.

From the perspective of activity systems, personal semantic networks do not concern individual life stories, but in the meeting of personal semantic networks and the shared object of the community, subjects are evaluated in relation to the shared object. In other words, personal semantic networks are of interests to us when analysed in relation to patterns of inclusion and exclusion in the activity.

As mentioned, activity theory sees disturbances as a possible challenge and subsequent change of an object, but disturbances like "in-appropriate/d others" (Trinh Minhha op. cit. Haraway 1992, 299) are equally likely of being excluded or forced to leave the activity. In this light, we see that motives in activity systems are formed in correspondence with the clusters of cultural models, which can act as inclusive in relation to the members of the community who *share* the same understanding of the object of the activity. On the other hand the members who do *not* share the same understanding of the object are at risk of being excluded from the activity. A workplace culture can thus be

[16] Partly inspired by Max Weber's notion of 'ideal types' (Weber 1905).

understood as a culture of members in a community engaged in an activity which can include or exclude members from participating.

In the research work, cultural activity is an analytical and relational concept. The cultural activity can be defined as 'national' in relation, for example, to habits (most Italians have for example learned that it is self-evident to drink coffee in a bar) but the activity could also be defined in other ways – for example as an institutional activity (e.g. physicists in a particular research group who have formed the habit of drinking instant coffee together every Friday). The definition depends on the researchers' frame of analysis. When we analyse the physicists' activity as *national* activities, one set of cultural boundaries emerges which separate the activity of the Finnish physicists from that of the Italian. When we analyse the physicists' activity as an isolated activity independent of the national origin of the practitioners, another set of boundaries emerges (Hercules, Caretaker, Worker Bee) which perceives physics as a global professional activity. From a critical realist perspective, cultural activities are real conditions of shared networks of connections which are self-evident for most of the informants. In order to truly understand the activity, we, as researchers, must (like other newcomers) learn what types of connections are accepted in the activity we study. We do not try to explain *how* the clusters of cultural models are formed in the activity[17], but simply take them as our starting point for the analysis of the physicists' activity as embedded in national cultures and as a globally isolated activity (subdivided into three ideal type cultures).

2.4 Summing up

Qualitative studies are complicated and data from individual scientists with different life stories are hard to generalize and the more comprehensive the project material the more complex the analysis. In this sense this analysis is no exception. One aspect that might have been

[17] This would, however, be an important contribution to how workplaces can be seen as activity systems, which might be difficult to develop.

further elaborated on in this publication is the correlation between our qualitative analysis and quantitative survey (Svinth 2008), as it to some extent supports our qualitative analysis.

Though we have tried to be as transparent about our research process as we possibly could, we know that many other issues influencing our research could have been brought up for discussion. One issue which we could have addressed more specifically is the possible implication of the fact that though the analysis for *Break the Pattern!* has been discussed by all members of the UPGEM team the text itself has been authored by the Danish team. We might sub-consciously have worked from a prolongation of our shared Danish cultural models if we have portrayed the Hercules culture in a too positive light in relation to other cultures. But we could also, with our stress on some of the very negative aspects of this culture, be accused of the opposite. We might, out of fear of being too biased towards a positive view on the Danish physicists, have exaggerated our negative findings.

In the theory of cultural historical understandings of human activity, words can be perceived as artefacts (Cole 1996, 122–126). In this sense, our etic categories and possible self-evident connections to other artefacts or words used in the empirical field that we as researchers have made (before we meet our informants) are included in our theoretical *a priori* categories. To unfold self-evident connections within *a priori* categories, it is decisive that the researcher does not assume to have knowledge of all the culturally informed connotations of the informants' words. Moreover, instead of assuming that the *a priori* categories are equivalent to the informants' emic categories the researcher must be prepared to be surprised by and discover the connections the informants make.

Methodologically this means that during the interview, and in the analysis, the purpose is not to take the informants' words as references points describing actual facts. Nor can we assume that the researcher's analysis of the informants' words is a mere construction created by the researcher. Though the whole of the analysis must be seen as a construction resting on relationships (rather than subjects uncovering objective facts), the purpose is to uncover as much as possible of the *context* in which the words are enunciated. The problem of conducting

research in a cultural context shared with the informants is the very fact that we share cultural self-evident meanings which may not be brought out for negotiation in the analysis. If the self-evident is not contrasted, no implicit comparisons can be made explicit – and thus our *a priori* (etic) categorizations remain unchallenged. The same goes for the emic categories (often self-evident) that are shared by researchers and informants. The categories that remain self-evident between the researcher and the informants may act as "backstage" conditions (Qvortrup 2008, 45) for the implicit negotiation of ascription of local self-evident connotations to words.

3.0 Physics *in* Culture

Physics is a highly international discipline with globally shared characteristics. For that reason it may be thought of as "an extreme culture of objectivity" (as mentioned by Traweek 1988, 162). In UPGEM we have, however, found that when studying physics as a case of workplace culture it is not unaffected by national cultural historical learning processes. The learning is centred on cultural models which the physicists share with other people in their national context. In this chapter, we concentrate on physics in culture and thereby on cultural models that are not generated within the activity of physics *per se*, but in the national cultural historical processes that create cultural diversity. We touch upon three salient but seemingly isolated themes which are the cultural model for the classical physicist, the cultural model for motherhood contrasted with parenthood including new masculinities, family life and its interplay with religion.

3.1 The classical physicist

In some cases the culture contrast method is relatively easy to use because the contrast occurs when possible connections are found in one context but entirely absent in another. In the cultural model for the classical physicist, we found a connection between physics and classical studies in Italy, which is entirely absent in all the other UPGEM countries. Nevertheless to reduce the complexity, we concentrate the culture contrast on Italian and Danish connectivity. Moreover, we found the contrast to be most salient between these two national contexts.

The contrast in possible connections was found when looking at the physicists' statements on high school education and starting physics studies at university. Under the theme 'career path' in our interview guide (Appendix B in *Draw the Line!* (Hasse, Sinding and Trentemøller 2008a, 375)) the researchers asked the scientists to draw a timeline of how they became physicists. They were also asked about their parents'

influence, the influence of teachers in school etc. on their motivation for studying physics, but no particular question concerning access criteria to university was asked. In all UPGEM countries, students can chose between classical, scientific or linguistic studies in high school. When analyzing the physicists' descriptions of their career paths we found sentences like: *Yes, the thing is that, let's say, even having done classical studies (...)* (P40, M, IT)); *Yes, at least classical studies* (P42, M, IT); *your parents they've filled your head that classical studies are the best because you're more how can I put it (...)* (P61, F, IT)*; I went to a high school specializing in classical studies, so it wasn't even a scientific education* (P71, F, IT); *[t]he one [a high school] specializing in classical studies* (P80, F, IT); *I attended the secondary school in a Liceo Classico [classical high school]* (P83, F, IT); *I have attended the high school specializing in classics* (P57, M, IT). In the Italian interview material quite a few physicists refer to their background in classical studies (14 out of 50 informants). In a Danish context, the dialogue quoted below would be very surprising, but in the Italian context it did not elicit any further questions about the strangeness of the possible combination, which indicates it is self-evident knowledge to both the researcher and the informant.

> Interviewer: *What did you study beforehand?*
> P77, M, IT: *High school – classical.*
> Interviewer: *Classical high school?*
> P77, M, IT*: Yes.*
> Interviewer: *So, when you were younger was there an event, a movie, a teacher, someone [who inspired you to study physics?].*

The researcher questions about the informant's motivation for studying physics takes them to the fascination of putting man on the moon.

Prior to the UPGEM project, Hasse (2005) has found that contrary to Denmark, it is possible in Italy to study physics at university with only a classical educational background. In the other UPGEM countries, but most explicitly in Denmark, students are typically divided in secondary school in groups of those who are interested in or

suitable for studying either scientific issues or languages and classical studies.

All the UPGEM researchers and interviewed physicists had self-evident assumptions of what it takes to become a physicist. But when we contrast what is found to be evident in the Italian context with what is found to be evident in the other national contexts, a cultural variation emerges. As our research developed, and we discussed this issue at our seminars, the researchers became aware, or even surprised, by their cultural differences. The Italian references to classical studies was commented upon as something unusual and innovative by many UPGEM researchers, which led the Italian researchers to ask their informants how it could be possible to study physics with a background in classical studies. Thus, through the culture contrast the researchers and, successively, the informants learned that their connection between educational background and access requirements at university might not be self-evident.

> P81, F, IT: *Ok. I went to a classical secondary school and then I enrolled in the physics faculty and I have to admit that apart from geometry, I had difficulty with the exams in physics and with analysis because my initial education was classical.*
> Interviewer: *How come that from the classical to – it is something that surprises people abroad, because it is only in Italy that we study -.*
> P81, F, IT: *Because I had a teacher of physics and mathematics that was really good (…).*
> Interviewer: *A woman?*
> P81, F, IT: *A woman, a very special relationship, very special, and I liked the way she was, her way of judging and teaching and so.*

In Italy, classical studies are found to be a good way into physics as they give a better understanding of the abstract thinking of physics.

> P81, F, IT: *No, not so much, it was therefore, let's say, a scholastic education, despite the fact that sciences are better taught in a scientific school than in a classical one, so a charismatic teacher who is very good is obviously good for a classical framework, so*

> *when I decided to chose such discipline as physics, I mean I was initially very indecisive, it was a scientific discipline anyway, so I was indecisive between biology, mathematics and physics. And then I started doing physics, I started following it and I could see here a very structured approach, almost familiar, the way it used to be at high school.*

In Denmark this would be considered an unthinkable approach to physics, whereas in Italy it is rather an everyday life experience that a classical high school education can give access to most higher educations. This issue has previously been discussed as two different cultural models of physics by Hasse (2005; 2008).

In Hasse's study, focus was on the contrast of connections between physics, hard science and masculinity on the one side and language studies, 'softness' and femininity on the other side in the Danish cultural model. This contrast was supported among other places at the homepage of the Danish Ministry of Education, where a number of articles presented un-reflected self-evident references to physics as a 'hard science' and language studies as 'softer' sciences. These associations are carried out as connections in practice. Female students in Denmark most frequently follow the linguistic line in high school and go on to study humanities at university level, whereas male students typically follow a mathematical-physical science line in high school and read physics at university (Hasse 2005).

As mentioned, different connections were possible in Italy and they relate to a different practice, because students can enter physics studies with a background in classical studies and, what is more, natural science does not carry predominantly masculine connotations. In practice, this was mirrored in the statistics of student intakes of which show that more than 40% of the students in physics were women and a third of these came directly from a classical high school (Hasse 2005; 2008). Hasse's argument speculates whether the preferential treatment of classical studies in Italy stems from the proud cultural history of the Roman Empire. Yet, at an UPGEM seminar in Rome, Professor Anna Maria Ajello, head of the Italian research group, refined the argument by adding that in Italy classical studies are connected to class society

and one's position therein. In other words, classical studies may be perceived as a type of "cultural capital" (Bourdieu 1977) and connects to the upper class of society. In this context, upper class does not only connect to wealth but also to degree of cultural education. Thus, in the Italian context it was self-evident knowledge that classical studies function as the best entrance to all higher educations, because this discipline is perceived to train people better for 'abstract academic thinking'.

> P74, F, IT: *I have always had a passion for mathematics, for scientific subjects and my mother had the same passion too. [M]y father, when we chose the high school, he chose the classical secondary school, and I admit that I would do it again. I [would] send my children to the classical secondary school, so, I liked my school and I had a lot of fun, always with a special attention towards mathematics*.

Generally, the physicists with a classical educational background in Hasse's study (2008), as well as UPGEM, consider this background an advantage when working as a physicist:

> P75, F, IT: *Well, to be honest, no, I consider myself very lucky because when I came out of high school, I had attended a school specializing in classical studies and not in scientific study.*

In Italy, people with their background in mathematics/physics are considered 'technical' thinkers while people from classical studies are considered competent in abstract thinking (Hasse 2005; 2008). Thus, a background in what Danes tend to admire as hard science (i.e. mathematics/physics) could be considered a less adequate background for abstract academic thinking in physics in Italy. The Italian connection between classical studies and abstract academic thinking is confirmed in the UPGEM studies, as indicated by the following quote from one of the Italian interviews:

> Interviewer: *Was there someone in your family who studied it [physics]?*
> P43, F, IT: *No, absolutely not, but you know I've always felt I had a facility for analytical subjects, that's how I call them, so, in high school I received a classical education.*

This male physicist explains how knowledge from a classical background may be integrated in studies of physics:

> P48, M, IT: *The fact is, I just couldn't wait to do physics, since back when we were studying philosophy, the ancient Greek natural philosophers, you know? When I read these things, I couldn't wait to look at them from another angle, the viewpoint of modern science, because obviously the ancient Greeks, though they were the pioneers, let's say, used a language that had nothing to do with the language we use today, which is the language of mathematics. So the trigger was partly that, and partly maybe Hawkins's book.*

Even though it is not uncommon to study physics with a background in classical studies, some researchers were warned that it might be a hard task awaiting them. But apparently the introductory courses in Italy make it possible to 'hang in' in spite of the less specialised education:

> P57, M, IT: *I'm very happy for the choice I made for two reasons. First, because it gave me the chance to study classic culture, Greek, philosophy, Italian literature. Second, because it's not a handicap at all, as I was told. (...) The first day at university, the Professor of mathematical analysis started to explain the straight line. (...) [S]o [those] who had attended a high school specializing in scientific subjects (...) didn't attend lessons during the first month. So, I had no problems*.

In the Danish data material, a connection linking classical studies to physics only occurred once and it was perceived to be totally negative:

> P27, M, DK: *You have to remember that most of this group of people [the Danish physicists] has chosen physics because they would avoid reading Greek and other foreign texts, and because they wouldn't have to write long essays and what not. Basically, they were able to be brief. It was hopeless to believe that well-written articles would come out of that!*

In the Danish context, humanities and natural sciences are not easily connected; in some cases it is even contested. It is not prone to be negotiated but taken for granted as a background for other discussions in the national culture. The self-evident understanding is that humanities are soft sciences, sharing little common ground with the hard natural sciences. Here it is a novelty and a creative act connecting the two otherwise separated areas.

In Italy the self-evident connection between educational background in classical studies and physics/natural sciences could be perceived as the result of a long cultural history, where the glorious Italian past of the Roman Empire influences present day academia (Hasse 2008, 127).

3.2 Cultural models for family

Questions concerning the relationship between children, women and work/family life reconciliation are recurring issues in gender studies. This has also been the case in UPGEM. Yet, the cultural models for family, which have been identified in the UPGEM research, are more complex than that of the classical physicist where the contrast was a matter of presence versus absence of specific connections. With respect to the models for family we find connections that are strong and even encompassing in one context and present but weaker in the other.[18]

A significant number of our informants note that reconciling a scientific career and family life is challenging for both men and women. Some of the physicists "go even further arguing that being

[18] The foundation for this analysis has been provided by research assistant Anne Bjerregaard Sinding.

successful in one field excludes the possibility of reaching the top in the other" (Chudzicka-Dudzik, Diekmann, Miazek and Oleksy 2008, 386).

> F[19], PL: *However, scientific work unfortunately requires sacrifices. It is absolutely out of discussion. I don't believe that people may be super in two areas – professional and domestic. Always, there is something at the cost of something else.*
> (Chudzicka-Dudzik, Diekmann, Miazek and Oleksy 2008, 386)

The majority of our interviewees, across nations, explain the low number of women in physics with the fact that women fit the physics research culture less perfectly than men, because women give birth (which entails time away from research) and take on the primary responsibility of the children (such as maternity leave, 1st day sick leave, pick up from kindergarten etc.).

> F, IT: *There is a difference between a man and a woman because of prejudices but also because of practical things, because you know, a woman must take care of children [and] parents.*
> (Ajello, Belardi and Calafiore 2008, 308)

It appears to be a general cultural model among the interviewed physicists that physicist couples (in UPGEM also referred to as endogamic relationships) with children have a division of labour in the private sphere which places the main responsibility for the children on the women[20]. Moreover, it is a generally accepted implication that this is a benefit for male physicists but a disadvantage for female physicists. This situation is supported by the fact that many of the successful male

[19] Some of the statements quoted in this publication are also quoted in *Draw the Line!* Yet, in the present analysis, the quotes are put into a new context. As mentioned, the physicists' P-numbers have been re-ordered in the composition of the culture contrast data base. Therefore, we have, as in this case, omitted the physicist's P-number when the statement is a quotation from either of the national reports.

[20] The notion of endogamic couples is also discussed in the individual national reports in *Draw the Line!*

physicists have partners who are housewives and are therefore able to concentrate fully on research and the engagement in work related tasks. Moreover, we have found no statements indicating that the male physicists carry the main responsibility for domestic tasks.

> F, DK: *It happens a lot that men have wives who work less. […] Often wives come along [on research stays abroad], take leave and take care of the family, for instance in many cases the wife works 30 hour a week or less, and the husband has a job that needs more*.
> (Hasse, Sinding and Trentemøller 2008b, 91).

> F, FI: *When children are very small, the men anyway, although they are very supportive in principle, they're here [at the workplace] and not there [at home]*.
> (Vainio 2008, 225)

As noted in the Finnish National Report: "A woman's work has to yield to her family's needs whereas a man's family has to yield to his work" (Pleck op. cit. Vainio 2008, 225). However, as part of the physicists' cultural model for family, it is generally perceived to be an advantage for female physicists wanting to work as scientists to marry (or live together with) a male physicist, as he will understand the requirements of the profession and the problems with a heavy workload in relation to family responsibility.

> F, EST: Estonian physicists: *My brother and his wife, they work in the same laboratory and my course mates are husband and wife, so they have the same job and so it's simpler, but if you do one thing at work and then meet a man and it's something different. He keeps yelling all the time: "It's five o'clock already, your working time is over!" [laugh]. Then it's very difficult*.
> (Velbaum, Lõhkivi and Tina 2008, 194).

Nevertheless, the physicists' statements also indicate that if other cultural historical learning processes maintain traditional gender roles, in which the woman is the main caretaker of the family, being married

to a physicist will not relieve her of the double burden of managing work and family:

> P93, F, PL: *The husband was a physicist, the wife was a physicist, they were working in the same division, in the same room, but (...) after work, I mean after coming back home, the husband was occupied with physics, the wife had to take care of the kids, for instance.*

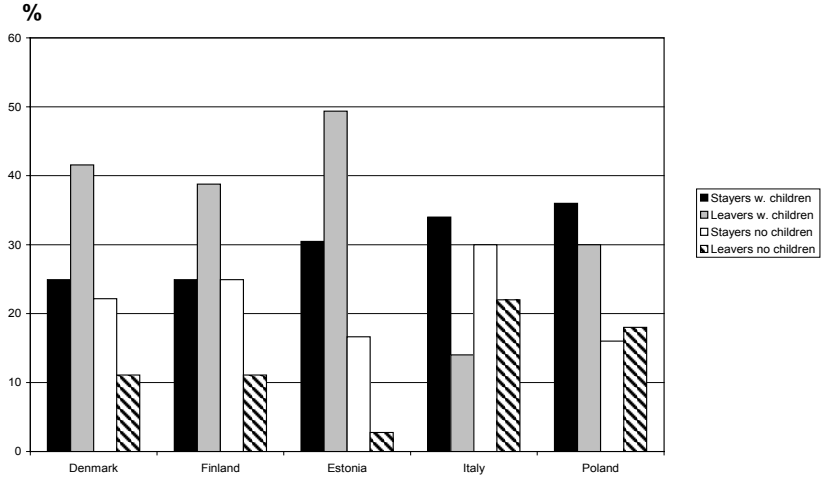
In this context, a number of the Italian female physicists point specifically to lack of public childcare arrangements as an impediment to the reconciliation of family and work life.

> P60, F, IT: *It's very hard to come back to work [after maternity leave], and obviously your work is affected by it because your mind is elsewhere. It's better now but for four, five years I couldn't concentrate completely on my work. I mean I did work but not as much as I would've liked to because I kept thinking about my son. I know that this problem is not only in here but everywhere in Italy. I have a Norwegian friend who lives here in Italy, I don't know why, because in Norway they help you so much, they have schools, support, for example young graduates receive a small loan, so they can leave their parents' house and they only have to pay back the loan when they find a good job. Like that you can have a normal life, the Government supports you, and this doesn't happen here in Italy, here you're left on your own.*

Because the physicists' cultural model for family is generally dissociated with work, and because they point to children as the main obstacle to the career, we expected to find more parents among our leavers and a majority of women among these leavers (as the female physicists are typically connected with the heaviest burden of childcare and house hold chores). Yet when we correlate our informants' parenthood status with their status as stayer or leaver, a surprising pattern emerges, which challenges our assumptions. Our first surprise was that the proportion of parents among the stayers and leavers differs

greatly across the five UPGEM countries. Denmark and Finland are relatively similar, whereas the picture is more diverse when looking at Estonia, Italy and Poland.

Figure II *Parental status of stayer and leaver physicists in UPGEM countries*

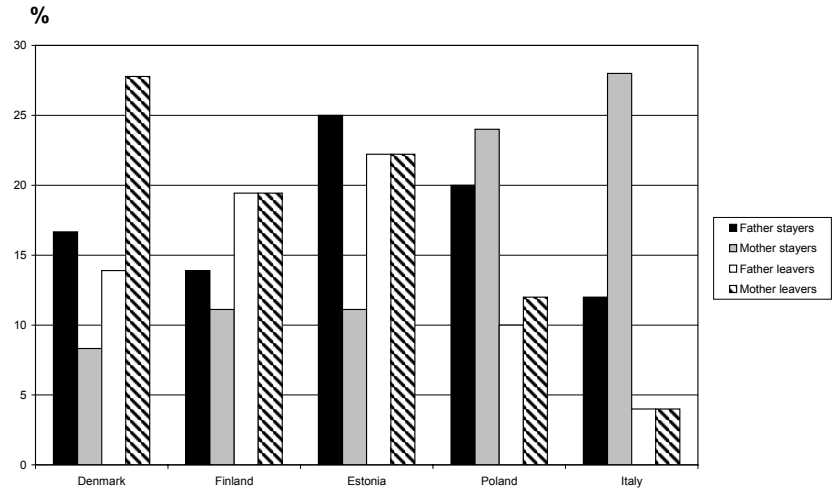


(For Denmark, Finland and Estonia the figure shows percentage of 36 people. For Italy and Poland the percentage is of 50 people.)

In Denmark, Finland and Estonia we see a pattern of parents being primarily leavers, while the stayers constitute the majority of the parents in Italy and Poland. The low percentage of parent stayers in Denmark, Finland and Estonia is particularly surprising as these countries have good parental leave arrangements and good public child care institutions. Because of the physicists' common conviction that women cannot be both mothers and (top) physicists, we also expected (bearing in mind the degree of public childcare facilities) to find a proportionally higher number of mothers among the stayer parents in the three latter countries compared to Poland and Italy, where one might expect the stayer parents

to be primarily fathers. However, looking at Figure III below, we see that this hypothesis is also not supported by the pertinent data.

Figure III *Gender of stayer and leaver parent physicists in UPGEM countries*



(The percentage is calculated on the following number of parent physicists; Denmark: 24, Finland: 23, Estonia: 29, Poland: 33, Italy: 24)

Denmark, Estonia and Finland have a higher percentage of mother leavers than mother stayers while the opposite is the case in Italy and Poland. With respect to the father stayers, we see that the percentage of father stayers is lower in Italy and Poland compared to the other countries – except Finland which has a higher percentage of father stayers than Poland, but lower compared to Italy. The two extremes in Figure III are Denmark and Italy. Here the mother stayers constitute 24.0% in Italy and only 8.3% in Denmark while the mother leavers amount to 27.7% in Denmark and only 8.0% in Italy.[21] In other words,

[21] Since this counting was not part of the quantitative survey in UPGEM and since we have not operated with representative and comparative samples from

the numbers from the UPGEM data material do not support the physicists' general cultural model for family that, irrespective of different national conditions, starting a family is at the expense of the physics career, particularly for the women. In order to better understand the reason for this surprising pattern of cultural difference it is necessary to conduct qualitative analyses of the everyday life behind these numbers. In doing so we have come across a number of connections, which seem to question whether the connection between women and family is the reason why women leave physics. Moreover, through analytical discussions of the qualitative research results we have gradually become aware that we, i.e. the researchers and our informants, attribute different emic meanings to the common terms division of household chores, child responsibility and family, which have functioned as our etic research categories.

3.2.1 Division of household chores: help and negotiation

To better understand the puzzling numbers in Figure II and III, we wanted to investigate whether the notion of family responsibility and household chores holds possible answers. The UPGEM interview guide holds a number of questions concerning family life, children and the reconciliation of these with work responsibilities (Hasse, Sinding and Trentemøller 2008a, 377). In the qualitative analysis of quotations concerning these issues, we find connections which seem to suggest that (contrary to indications of the numbers in Figure II and III) female physicists have more difficulties making careers in Italy and Poland (and to some extent Estonia), because they are closely connected to family obligations and household chores.

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each of the UPGEM countries, we are well aware that these numbers are only indications, which should be followed up by more substantial quantitative surveys.

> P108, F, PL: *[I]t quite often happens that only one of the spouses is working. Very often a man goes away and a woman must take on the role of the person who caters for the whole family.*

> P57, M, IT: *(...) in our society the woman manages the family.*
> P181, F, EST: *I felt really sorry for those women [her physicist colleagues] who had to provide warm meals every day.*

Or as this male physicist emphasises, new technological developments have eased women's work load in the domestic sphere which exempts husbands from helping:

> P112, M, PL: *And I think that right now, generally somehow, the position of a woman starts to change for the better (...) for instance that a woman is less burdened. For example, she doesn't have to do the washing in some primitive [conditions]. It's difficult to avoid washing at all, for it's this side of activity in marriage, [which belongs to] a woman. (...) If she had some tare, I would help her, well, but it's not necessary. There's certainly more equipment in the kitchen. So all this works in support of a woman.*

More often, however, the Polish and Italian female informants tend to describe the division of labour in the private sphere as one in which they receive help from their husband, family or nannies, rather than sharing the daily chores.

> F, PL: *I actually see, with huge satisfaction, that the male colleagues, especially the young ones (...) obediently get home at this two-three o'clock. [T]hey also collect those little kids from the kindergarten, from school, they help. Here, there is really, in my opinion, a huge progress.*
> (Chudzicka-Dudzik, Diekmann, Miazek and Oleksy 2008, 392)

> P131, F, PL: *Well, but to sum it up, I guess, there was indeed big help from my husband where he helped just [with the] little children a lot, you know. He went for these walks, and when it was necessary, he stayed at home and stirred porridge, too.*

P44, F, IT: *Yes, I had a baby sitter helping me, of course (...) [F]irst she [the child] went to a day nursery school and then to a kindergarten, until 4 o'clock in the afternoon more or less, and then, at 4 o'clock I was still at the University, so I could not pick her up and so my baby sitter would do it [unclear] the baby sitter would take her from there and (...).*
Interviewer: *I see (...) but why. Were you on your own?*
P44, F, IT: *Oh no, no, they have a father as well, but he works (...).*

P52, F, IT: *[I]t is possible that Italian women are more emancipated, but they don't have infrastructures to help them with their children. If they can't get grandparents' help, [they have problems (...).*

P45, F, IT: *Well, it's difficult. [Y]ou make flips, you need help, you need a baby-sitter. I have to say that since I've worked part-time things go better, I can go to fetch my child.*

But we also find an example where the woman underline that spouses help each other just as much as the husband help the wife, but often other family members are involved.

P55, F, IT: *I remember being frustrated when I could not attend meetings or do something because my baby-sitter could not come, and it was very helpful having a husband who is doing the same thing and is therefore very comprehensive about the way this job goes, its pace, its necessities, so we helped each other.*

P125, F, PL: *For once, I have a very good husband. I have to admit that he's got nothing from the type who wants 'his woman' to serve him, do the laundry, iron his clothes, etc. He's a totally different character, you know. We have partnership relations. He's always been very helpful and we have always managed to move on.*

Women are largely expected to take on the main responsibility for taking care of the family and to arrange help from nannies or family members. This connection of household chores and helping the woman is contrasted with a cultural model for family found among the Danish, the Finnish and to a lesser degree the Estonian physicists, who tend to describe the division of labour in the private sphere as a negotiation based shared responsibility.

> P7, F, DK: *We have talked about my boyfriend working part time if we should be able to manage, because I will not give up working full time to have a child. And I feel sorry for those kids who are dropped off at kindergarten at 6.30 and picked up at 5.*

> P33, F, DK: *My husband and I sat down and wrote down the number of hours we worked in the house and we reached the conclusion that there were many of them we couldn't use so we hired an au pair.*

> P24, F, DK: *We sometimes have different opinions, and then you have to discuss that and see what you can get through.*

> P140, F, FI: *[W]e don't need to make compromises. Things seem to run quite easily. Sometimes we will have a discussion about, especially at one point when we were in the same office, when both of us wanted to finish the project and we had to go get the kids from day-care. It is one of those things that when a person is in a certain mode, then the movement to a different mode is very difficult. (...) But it can easily, when you are working here, you can sometimes forget that you have a family. Some might think of it as cold.*

In this cultural model, husbands are not considered 'helpers'; they take part in household chores, which is not praised as something special:

> P169, F, FI: *Well, the support really [did] that I was able to do this sort of work. Well, my husband started to vacuum much more around then, or do housework like that, but nothing radical. Just*

> *that probably affected things that everyone was used to the fact that I corrected exams and planned lessons at home and so on, anyway- And I could do something like that*.

> P170, M, FI: *[W]e both do everything. I do the laundry and the dishes and she does the laundry and the dishes and that's it. We don't have a division, like things that we always do, instead we both do everything.*

Of the three Nordic UPGEM countries, Estonia seems to be in a transformation phase in which younger physicists discuss gender roles while the elder generation accepts the more traditional gender roles in which the woman carries the main responsibility for family care.

> P199, F, EST*:* [My husband is] *all the time occupied, all the time busy. Of course I have to fight with him. I mean, we wrote a list of tasks, [laughing] like that. But it's very difficult. And I feel sorry for him because he has so much work that he doesn't even have time to sleep. And when he wants to sleep, I naturally wouldn't force him to do the dishes [laughing]*.

Based on the above statements from both male and female physicists, our data material does not seem to hold any explanation as to why or how the Italian and Polish mother stayers manage to stay in physics while taking care of the family. On the contrary, we have found two cultural models of family; one in which responsibilities for family life can be negotiated between men and women and another in which the overall responsibility rests on the woman – she may receive help but cannot negotiate chores.

When looking closer at the negotiating relationship between partners in the Nordic UPGEM countries and including the role of children in the analysis, it becomes even more puzzling that we find more female mothers in Italy and Poland compared to Denmark, Finland and Estonia. In addition to the more elaborate state funded support of childcare in the Nordic UPGEM countries, we find signs of a new masculinity emerging here in society and within physics (Hasse, Sinding and Trentemøller 2008b, 107).

When running an ATLAS.ti count of the number of statements concerning our etic category 'children' among the *male interviewees* in our data material, the following numbers emerge (221 statements in all):

Table 1. *Number of statements relating to children by male UPEM physicists*

Males from:	**Denmark** *(16 males)*	**Estonia** *(18 males)*	**Finland** *(18 males)*	**Italy** *(22 males)*	**Poland** *(23 males)*
Number of 'Children Quotations'	**79**	**35**	**23**	**30**	**54**

Though the Danish material holds the fewest male informants, it still holds the most quotations on 'children'. From that we can gather that the Danish male physicists talk more about and relate more to the aspect of children than men in the other UPGEM countries. Our argument focuses primarily on the connection between men and our etic category 'children'; but, it should be mentioned that the cultural model for new masculinity integrates more aspects than attitudes to fatherhood.

In analysing the 221 statements we find that the foundation for the new masculinity is part of a cultural historical learning process, which can be found in varying degrees in all the UPGEM countries. Moreover, we find that this cultural model for new masculinity primarily applies to the younger generation of informants in Finland and Denmark and to some extent also Estonia.

> P172, M, FI: *I don't know. I think, in hindsight, that I have neglected my family, my wife and children, outrageously. Especially in the early years, when I was at home, I wanted to read or do something on the computer.*

> P20, M, DK: *(...) He will be 70 this year. He has three children, but his wife has stayed at home taking care of them. (...) When their wives tell the stories of the first field trips their husbands were part*

> *of in the 50s and 60s, it's a story of a want of their husbands. The husbands were simply gone, and all they got was the occasional telegram saying that they were still alive. And there was no choice for them but to look after the kids at home. Our generation is different in that aspect. [My wife] and I have divided it between us.*

In Poland and Italy, a similar generational change does not seem to have taken place. In Poland we find a particularly weak connection between children and fatherhood:

> P132, M, PL: *Well, at the time, when I was leaving for [X] for the first time, there was a dilemma, for there had already been one child, (...) but this proposal was so fantastic, that in fact, as a result of a certain agreement with my wife, I decided to leave, but it was very difficult. This I don't hide. So perhaps I assessed the career higher than the family at that time, this I must admit.*

In the Polish and partly Estonia cultural models men are less connected with the responsibility for childcare, and fathers can more easily go away for longer periods of time without their families.

> F, EST: *[...] and in the morning he's* [her male colleague] *there before nine o'clock, and in the evening he leaves maybe after nine o'clock, sometimes earlier. And at times he's abroad for months. At weekends he conducts experiments. For instance, yesterday he was still working at eleven in the evening. I don't know if he considers his life, his family important. I don't know, maybe he himself actually does consider his family important, but I, when I look at him, it seems to me that he doesn't consider his family important [...].*
> (Velbaum, Lõhkivi and Tina 2008, 196)

> P127, M, PL: *[My boss] says: 'You are going to Moscow for half a year'. 'When?' 'In a month' Well, my wife was pregnant, nine months pregnant, and I came – for she was at my parents-in-law – it turned out she had already gone to hospital, and shouting through the window to each other I said: 'I am going abroad in three weeks.' She*

accepted the message. The child was only born just then, so throughout the first half-year I was not with my older daughter at all (…).

Moreover, in the Polish cultural model for masculinity, there seems to be little acceptance of men choosing to go on leave because of their children.

P114, F, PL: *Men do not take maternity leaves. They don't get pregnant, don't take leaves – usually, there are some case, though. I know a physicist – yes, I've just remembered a man who started working when I did, he was a lecturer. I think, I don't know, his marriage was shattered and I think he took a parental leave and had to bring up his child.*

The Italian and Polish males rarely express attitudes to fatherhood that fall in the category of new masculinity. But, we do find that especially in Italy, male physicists have very high regard for their family.

As mentioned above, the development towards the new masculinity, which involves new connections with 'fatherhood', is a learning process that, in some of the national contexts, takes place 'inside' and 'outside' the physics activity. In Denmark and Finland laws on paternity leave assist in leading (albeit slowly) men to be more and more interested in sharing the parental leave with the mother of their children:

P9, M, DK: *Clearly a woman needs maternity leave in the beginning, the first six months. But personally I would want half of that. I would want as much as I could get.*

Male informants with characteristics of new masculinities do not only talk about children they also actively seek more time with their children (and consequently less time on research).

P139, F, FI: *One of our researchers is going to stay home this fall with his little girl; the wife is going to work. I think they [men] do take care [laughs], take care of the kids and share the responsibility. And talk about children.*

> P18, F, DK: *[T]here was someone [at the department] who became a father. First, he had fourteen days and then six months of paternity leave. I think it grew more and more [common] that not only the women go on maternity leave but that the men go on paternity leave as well. And they have to go pick them up or have the child's first day of illness. I think so, and it is so here too, and it is balanced between the sexes.*

Moreover, we find a noteworthy number of younger males who chose to abandon their career in physics if they find the workplace culture hostile to children.

> P12, M, DK: *[I] left research because of the children. Well I think I did it, because I thought it was important to own a house and to be with my family. So yes they have been a great deal of the reason to why I left research.*

To sum up, we can identify different connections between gendered responsibility for care for children in the Polish and Italian data versus with the Danish and Finnish data. These clusters of connections we define as different cultural models for motherhood and parenthood.

3.2.2 Motherhood or parenthood

As we have seen, the Italian and Polish data material holds numerous examples that the women are in charge of family responsibilities while husbands primarily give a helping hand. Children are perceived to be primarily connected to motherhood as the children are connected to the mother as *her* responsibility. In this cultural model for motherhood, this role appears inescapable for women as the physicists connect it with biological determinism.

> F, PL: *I don't feel discriminated at all. (...) On the other hand, I believe that it would be easier for me if I were a man, because, for example, I might not feel that attached to my child. Even in*

> *biological terms, because my husband works, even though he would like to spend his time at home, but it is a mother who is most of all necessary for such a small child. But a woman is, even as far as psyche is concerned, more family-oriented and that hinders her scientific career. It is not that they [women] have to resign completely or partly from their career in order to devote themselves to their families, but very often they want to. And this is such a biological condition which hinders their career, because spending time with children results in the fact that there is less time for professional work.*
> (Chudzicka-Dudzik, Diekmann, Miazek and Oleksy 2008, 396–397)

> P99, F, PL: *Well, but a woman, exactly due to biological reasons, has a problem (...) There are problems at home, in the family, at least, let's say, a child gets ill, well, then the husband will not be running around with this kid, we would rather point to a woman. That's biology and that's all.*

> P47, M, IT: *[B]ecause at a certain time women physicists start thinking that they cannot concentrate just on their own careers and therefore they choose to take care of their family. So they take their maternity leave for one year, but during that time they don't publish anything, whereas their male colleagues may publish ten articles. Therefore, when researchers are selected to give them a promotion, male physicists are favoured. (...) [U]nfortunately, there is nothing to do [laughing]*.

In some cases, however, the Italian women do take a critical stance toward the notion of motherhood as biologically determined and indicate that to some extent the women themselves take on this role because they see no other way of being a mother:

> P38, F, IT*: Even though I must say I have met some evidently chauvinist professors; I've always thought that this situation was our, women's fault. Find me just one example, a woman who is eager to leave her children with a father in order to go back to work*

> *without worrying, and to give up on her optional maternity in favour of the husband. And then women complain about being discriminated because they spent a year at home after the pregnancy and the childbirth. (...) I see that women stay home, don't let them [the men] be on this paternity leave! well, he might not want it, but women don't seem to insist either, I mean when you have your colleague say to you that she does not trust her husband enough to let him stay with their son in the evening so she can go out, for God's sake!*

Another aspect of this issue could be that for the Italian women leaving a child in a public institution could be perceived a maternally awful act:

> P51, F. IT: *[I]n Italy (...) women get severely punished by that thing, they are considered heartless if they leave their kids.*

Paradoxically, the physicists describe this connection of mothers and children as an essential obstacle for female physicists:

> P47, M, IT: *[T]here is [a] big problem in Italy: motherhood is an obstacle to career. (...) Motherhood isn't given any points in a competition.*

Though motherhood is primarily salient in Italy and Poland, a number of the Estonian interviewees express a strong connection between motherhood and biological determinism:

> P187, M, EST: *[T]here's a certain asymmetry between men and women, resulting in, when having a family is in question, children placing greater demands on women (...). Biology is what it is and therefore it's inevitable as far as the working time is concerned; women with children, especially small children, their working time is considerably limited.*

As mentioned previously, the Estonian data reflects a nation in transformation. Thus, despite statements defining the model for motherhood

as biologically determined, we also see a tendency in the younger generation toward parenthood. The social norm may go toward gender equality but, particularly with respect to children, we find examples of mixed attitudes:

> P174, F, EST: *There are men, who are ready to sit, somehow feminine men. I don't need that kind of a man. I need a normal man. [Feminine men are] the ones who'd agree to sit at home with the child so that I can have career. I don't know. I'd rather my husband had a career.*

The connection of gender roles and biology stands in clear contrast to the majority of the Danish and Finnish informants' statements. If gender roles and biology are connected it is not a connection that excludes fatherhood.

> P9, M, DK: *Of course there is a difference in what children mean to men and women because the women have to…you know, breastfeed and things like that. But I think that you can be just as close to your children as a man.*

As we have shown, we find numerous examples of physicist parents who share the obligations and care for their children in the three Nordic UPGEM countries. Though there may still be tendencies toward a closer connection between children and women, the younger generation of men are also highly engaged and interested in integrating their lives as fathers in their workplace context.

> P11, M, DK: *There are not as many details when men talk about children. As in what kind of school they went to and what kindergarten they went to and so on. It is more the outward things you talk about. But I do not think we are different than other men. [Women] just use more time about it. They can spend a whole evening on that subject. We can not do that. We might compare the children's mentality and tell long stories about what they did then and there.*

> P140, F, FI: *I was actually just laughing about that earlier, when I was sitting and having coffee, and a young father with a group of engineer men were discussing due dates and paternity leaves and so on. So it is more and more that quite a lot of people here will take parent's leave and men will talk about their children. Quite a lot really, I feel like young men speak more about their families and children than I do.*

Through qualitative analyses (based on the culture contrast method) of our etic categories of family responsibility and children, we claim to see a distinct contrast in the cultural models of parenthood. In the Danish and Finnish context, children are equally connected to the mothers and fathers whereas in the Polish and Italian context, children are connected to the mother as *her* responsibility. Due to the different workload connected to motherhood and parenthood, it appears that becoming a mother implies widely diverging consequences for women in the different countries. However, these diverging consequences do not offer an explanation to why we find more mother stayers in Poland and Italy compared to the Nordic countries.

3.2.3 Contrasting conceptions of family

Though we found the family responsibility to primarily lie with the women in the Polish and Italian cultural models for motherhood, we also find that they do not manage these household chores alone. Our studies show that the women in the extended family tend to provide more help and support than the husband/male partner. Based on the narratives of the interviewees, we can identify a cultural model for family which is common to the Polish and the Italian national contexts, but differs from the (more or less) shared Danish, Estonian, and Finnish cultural models for family.

When the UPGEM researchers ask family related questions, some of the Polish physicists point out that the term family can be understood both as the 'first' (i.e. the physicist's parents) and the 'second' (i.e. spouse and children). Another indication of the two understandings of

the term is reflected in the following quotation from a Polish interview situation:

> Interviewer: *Did your family support you in your scientific career?*
> P96, F, PL: *Family or husband?*

In the Italian National Report, the UPGEM researchers also refer to the first family as "the domestic family" and the second family as "the new family" (Ajello, Belardi and Calafiore 2008, 279), indicating a shared cultural model for family in these two national context; family can refer to either the first family (the birth family) or the second (the marriage family). This cultural model for family is very different from the Danish, Finnish and Estonian cultural models where the physicists' conception of family is connected to their spouse and children. In situations where the interviewees are not in a stable relationship, they often stress that they have not yet created a family:

> P9, M, DK: *I do not yet have a family myself.*

Thus, a distinction between first and second or domestic or new family never comes up in the Danish, Finnish or Estonian data material. Nonetheless, we can say that in these contexts, the term family seems to refer primarily to the equivalent of the 'second' family (the marriage family). In the following, we refer to the Polish and Italian cultural models for family as the 'extended' family network and the Danish and Finnish cultural models for family as the 'nuclear' family network. To clarify the implications of these different conceptions of family, we looked for accounts of the physicists' relationships to other members of their family. In this investigation we find that when the female physicists live in cultural models with fixed gender roles and a national context which offers little state supported childcare facilities, the extended family comes to play a noteworthy role in the connection with children. References to kindergartens and day-care are, not surprisingly, most frequent in the Danish, Finnish and to a lesser extent the Estonian and Polish contexts, but almost none existent in Italy. The provision of public child care arrangements differ widely in the five UPGEM

countries and affect the practical organisation of the everyday life of young couples with children.

The Polish and Italian mothers largely rely on help from grandmothers in relation to reconciliation of work and family, but other family members such as aunts, sisters and sisters-in-law are also mentioned as providing support in relation to child care. In Poland, the physicists with children often refer to the help of their parents as crucial:

> P103, F, PL: *I had somebody who could baby-sit my child. So, I even explained to my professor that there's no problem for me to come back to work after maternity leave, because I had somebody to look after my child; there's one grandmother, and the other one could have possibly helped too.*

> P120, F, PL: *Well, the problem is in fact this whole parting, not my leaving itself. Of course, they suffer a bit that I'm not home, for it's obvious my husband has more duties. It's obvious, but one grandma and the other [could] help, so there is no problem.*

Moreover, in a Polish instance, a grandmother moved in for several periods of time and took care of her son and grand children when the interviewee was abroad (P134, F). This case is, however, outstanding both in terms of the grandparent's involvement but also in terms of the female physicist's break with traditional gender roles; she is the only example of a female physicist who leaves her children repeatedly.

In the Italian data material, the grandparents also play a pivotal role in relation to reconciliation of work and family life:

> P58, F, IT: *[M]y daughters, now that school is over, must stay with their grandmother in [one town] and then with their grandmother in [another town], it is obviously hard but it is possible.*

> P72, M, IT: *It is complicated. We have grandparents that are helping us. And then when our son was born we decided not to work at weekends the way we used to, 'cause it was normal for us to work together on Saturdays and Sundays, we don't do it anymore.*

In some cases, the Italian grandmothers also move into the house of the female physicist where they function as baby sitters, or follow the mother around (even at the workplace) helping her with the children or stand by if meetings suddenly come up.

> P82, F, IT: *I have a wonderful mother and father. I mean (...) my mother used to push the baby carriage during the meetings; (...) my mother followed me everywhere. Now like today we had a faculty meeting in the afternoon, they [the grandparents] pick her up at school they come here.*

One Italian female (P86) laments that the grandparents do not live close by and therefore cannot help. Another underlines that she prefers grandparents to day-care nurseries because the latter do "*not help women; on the contrary, it is against women, many times because of its management, in the sense that it is closed too many times"* (P74, F, IT). Other Italian and Polish physicists also see advantages in using the extended family network rather than the public day-care system because it allows them more flexibility.

In the Estonian case, the grandparents seem to participate less in child care tasks just as they do not play the same role in making everyday life run smoothly (they are, however, spoken about as crucial for (P196, M, EST), (P193, F, EST), (P198, F, EST) and (P199, F, EST).[22] For the Danish and Finnish physicists, grandparents are only very rarely mentioned as having a crucial impact on making the everyday life of the family run smoothly (e.g. P154, F, FI). Following our argument above, this correlates with the fact that Denmark and Finland offer affordable public day-care for all children. In Estonia the

[22] We are well aware that some of the differences found may be due to the diverging number of interviews (50 from Poland and Italy and only 36 from Estonia, Denmark, and Finland). Rather than looking for number of statements, we look for new approaches and tendencies, which could be explored further by quantitative surveys. The lack of references to grandparents in these countries and the many references to grandparents in Poland and Italy fit a pattern seen in relation to the overall analysis of data.

physicists find that the standard of public day-care has deteriorated since the communist era.

> P197, M, EST: *And also, well, let's say, we still have the kindergarten, it keeps working, but let's say in Estonia as a whole this looking after the children this is like in the Soviet times, in the Soviet times there were quite many kindergartens – this system collapsed in the meantime completely, well, not completely, but pretty severely. It was privatized and so on and now they haven't managed to develop it again.*

The same situation has, to some extent, been experienced in Poland; today it is necessary to pay for facilities that were previously free.

> P134, F, PL: *[It] is happening at the expense of some kindergartens, grannies and some nannies. For a female doctoral student of mine comes here and obediently works from morning till evening, but the nanny is at home at that time, right? So, you know, one has to have money for that as well, of course. So, instead of a holiday, or even investing in a house, or a flat, or a car, people invest in housewives, actually, or they organise this time for themselves in some way.*

However, even though public kindergartens are widespread in Denmark and Finland, the physicists describe the public childcare system as somewhat inflexible and therefore problematic to fit the working hours:

> P3, F, DK: *And it is the question of who picks up the children that puts a limit to your daily work. If you really want to get some things done this often entails staying until after the day care has closed. So that was a bit of a problem and it lasted for a couple of years. But apart from that it has mostly been a fifty-fifty split [between me and my husband]*.

We find that the cultural model for the extended family in Italy not only covers aspects of bringing up children, but ties the members of the family together in a network of social obligations. It is not uncommon that the Italian physicists are economically dependant on their parents

until they are approximately 40 years of age (due to problems of little pay and lack of positions):

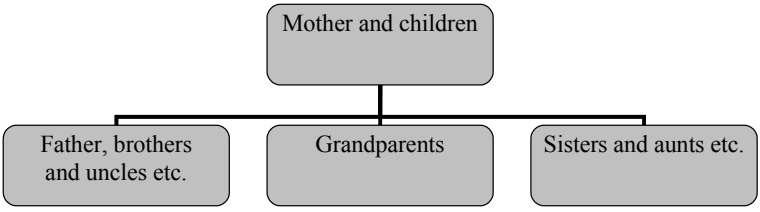
> M, IT: *You might be victim of a social selection in physics, because if you don't have a family supporting you when you don't have a contract or a scholarship and you really need some money, you have to change your job.*
> (Ajello, Belardi and Calafiore 2008, 284)

> P50, M, IT*: [A]n academic career is not an easy career, not controllable, therefore the fact that I had a well-to-do family behind me allowed me to risk more than a person in a different situation would have done. (...) [O]bviously I never used my family, I mean I never took advantage of it, my parents never had to support me, I was making my own money, but then it is obvious that I could make more risky choices compared to other people.*

Among the Polish physicists we also find some who live at their parents' or grandparents' place far into their career.

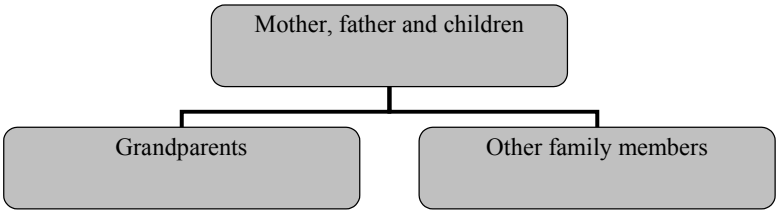
The following figures illustrate the different cultural models for family based on the woman's relation to children, husband and other family members.[23]

Figure IV *The Italian and Polish cultural model for family*



[23] It should be mentioned that these models illustrate the analytical lines we have drawn. We are for instance aware that couples can live together and be part of the family structure without having children.

Figure V *The Danish, Finnish and (to some extent) Estonian cultural model for family*



The models build on descriptions of relations with (first and second) family including narratives of who in the family the physicists go to for help with children or other types of help like financial support. In Denmark, Estonia and Finland the physicist's statements confirm the outspread tradition for moving away from home at an earlier stage compared to the Italian and Polish informants. In the former countries, the young must often manage on their own (though state support should not belittled in this context) whereas the young in the two later countries dependent more on their parent. This forms closer ties to their parents who in some situations are placed on the same footing as a spouse.

3.2.4 Strategies for work and family reconciliation

To be able to cope with the workplace and family responsibilities simultaneously, mothers must, on the one hand, make use of their mothers and babysitters and, on the other, be able to break down the borders between work and private life. The borders become blurred as the women move forth and back between work and children (including babysitters and grandparents).

Thus apart from making use of family relations and public child care facilities, the physicists also employ private help. In Denmark we find few references to au pairs and housekeepers and in the other UPGEM countries, not least in Italy and Poland, the physicists refer to baby sitters or nannies as a necessary help. A number of national cultural

historical factors may affect how affordable the private help is for the families. In Italy a huge number of illegal immigrants offer their help at very low costs (Reyneri 2001) and in Poland and Estonia new solutions have had to be found, as the state supported kindergartens gradually have been exchanged with more private solutions.

> P70, F, IT: *[For] those who have children it's a problem, because either it's a nursery or changing a babysitter. Anyway, me, until recently, as I was breastfeeding Luigi in the afternoon, I was working for 2 hours, then I'd go home to feed him and then I'd come back to work.*
> Interviewer: *Do you live nearby?*
> P70, F, IT: *No, I don't live close to the institute, but he would stay with his babysitter at my mother's who lives a bit closer to here; anyway, you get organized somehow; but managing your time is a very common problem, because everybody feels that they spend a lot of time here, doing their work that is really very engaging anyway.*

Even though the Italian female physicists experience the need to show themselves at the workplace (even as early as 15 days after birth), they manage with the help of the grandmothers and babysitters.

> P80, F, IT: *There was a girl coming to my house (...) I was breastfeeding early in the morning, then I would leave some of my milk in a feeding bottle. Then I would go to the department, pour off the milk once again, but this second time I wouldn't use it and then I would return to breast feed him again. That way my son had one proper breastfeeding and an artificial one. Then I would return. It was all organized.*

> P44, F, IT: *I gave birth to my second child (...) I'd bring her with me to the University, with her babysitter in the room – in the empty hall, next to us, and she would wait for me and call me when I had to breastfeed, I mean, that's how (...), I wasn't the only one, many of us [did] this, and we would just hang around with the kids at the university, as I*

> *needed to breastfeed the baby, so, anyway, she would bring it to me, so I had this babysitter who would come along with me.*

As can be seen from the above quotations, a connection between breastfeeding babies and the workplace seems acceptable in Italy. Since the women are so strongly connected with the children in the Italian cultural model for motherhood, it may make it easier to accept that motherhood also has consequences in the working hours. With respect to support of female physicists with children, it seems the family as well as the workplace culture sustains the mother in the fixed gender role. Here the Italian physicists are described as especially helpful.

> P58, F, IT: *You must plan everything and you need a husband who helps you, who collaborates, I see other friends of mine whose husband does not help them, but not in this sector I must say. I think that the Italian middle male physicist is really helpful, my husband is an exception, he is maybe more helpful than other colleagues, anyway my colleagues collaborate, help their wives and work (...).*

In fact, the breaking down of borders between work and family seems to apply to the male physicists too, even though they are generally not considered responsible for child care obligations:

> P46, M, IT: *I remember a dear colleague of mine I shared the office with who had a child. (...) He brought his child at the office in his baby carriage. (...) He used to write on the blackboard while moving the baby carriage to and fro not to make him cry.* [24]

That children and fatherhood is generally not connected to work is reflected in the following quotations from male researchers in Poland and Italy:

[24] Several Italian physicists praise their workplace for being very good at integrating family life with work life, but since some of these are currently working in France, they have not been included here.

P45, M, IT: *I think research is a passion, a reason to live for, I think family is not prioritized by researchers.*

P41, M, IT: *I would say that most of the physicists I have come across during these years dedicate themselves much to research and little to (...) their families.*

P90, M, PL: *[C]ompared to other people, family is not of primary importance among scientists. It's not given the priority. Many people believe, and I think they're right, that focusing on family prevents one from making a career, a scientific career in particular.*

Because the connection of children with motherhood certainly places more family responsibilities on the women's shoulders, the cultural model may lead to acceptance of women who need to leave the workplace early because they have to take care of their children. In Poland we do not find examples of breastfeeding at the workplace, or other steps or signs of integrating work and family life. Indeed the strong connection between children and motherhood may make it easier for women to be accepted as working mothers – not just as physicists.

P132, M, PL: *Well, there are much fewer ladies, but yes, yes, it would happen. It would. Actually, among those research workers we had two ladies, and they indeed more often benefited from this motherhood, or not only motherhood, but of the fact that they were of a different sex.*

In Denmark, however, motherhood must not come in the way of research in the physics activity. In the quotation below, the female physicist stresses the contradiction between the attitudes within the research environment and society in general.

P4, F, DK: *[In Denmark] employees are expected to have children and you are expected to go on full maternity leave as opposed to the expectations within the scientific research milieu. There you do research even though you are on leave. You do not put your work*

> *aside for a year of breastfeeding; you work and publish papers while you are on maternity leave.*

Nonetheless, we find exceptions within the Danish context in which the workplace cultures is friendly to the connection of children and work; see Hasse, Sinding and Trentemøller (2008b, 108–110).

> P21, F, DK: *And if there is a child sick that is never a problem and we help each other take care of classes and what not. I think we have very child friendly politics here. But it is something we disapprove of at the rest of the [physics department], because they schedule their meetings late and things like that.*

3.3 Cultural model for the interplay of religion, science and gender

As our last example of contrasting cultural models, we examine national cultural differences concerning the interplay of religion, science and gender. Even though the physicists generally agree that religion and science do not influence each other as much as in the past, we find a clear contrast in how much our informants engage into the discussion of religion.[25]

In the Catholic countries in the UPGEM study (Poland and especially in Italy), the informants have much to say about the relationship between research and religion. They express this relationship in two ways. Firstly, religion is seen as an ideology, in which mankind and the physical world is perceived to be created by God. This approach is challenged by physicists' theories of the creation of the universe, which has led to an ongoing fight between science and Catholicism and to the establishment of the Vatican's own research and observatories. Secondly (and this yields the most comments among the Polish and Italian physicists), the physicists describe Catholicism as an ideology

[25] The foundation for the analysis has been provided by research assistant Agata Heymowski.

with political and societal impact. The physicists discuss how the state finances churches rather than research, and that priests interfere with public debates e.g. on family issues. Although it is generally agreed that the Church does not influence directly on physics research in Catholic countries, it is implied that Religion may have an impact on funding and the public discussions of science.

> P118, F, PL: *At present the Church has no such power that could suppress the development of science, however, it still has the so-called mental power over the human minds, and this is connected to money. If a society doesn't accept something, politicians do not vote for it. If they do not vote for it, there is no money for that and the development of it is very insignificant.*

Another Polish physicist adds:

> P117, M, PL: *On the other hand, if you're talking about a broader aspect of this problem [influence of religion], if we spent half of the money we waste – I said 'waste' in inverted commas since this is a very subjective issue – so if we half of the money we 'waste' on building churches, spent on science, then you could certainly said that Poland, a Catholic country, is on the right road to changes. I would definitely say that this money could be spent in a better way than building churches which, by the way, are becoming more and more deserted, so not long and they will be completely empty, and the money in my opinion will be wasted.*

And the Italian physicists share these views:

> P84, M, IT: *There might be a link between the lack of funds to research and the power exercised by the Catholic environment in Italy.*

> P77, M, IT: *So one of the things is that the Catholic power groups exists, so in this sense the fact that there exist strong Catholic power groups they influence ehm the selection of people in the University and thus it influences the spreading of culture and the research model.*

In the predominantly Protestant (but rather secular) countries, Denmark, Finland and Estonia, the relationship to religion is more neutral and the influence of religion on science is seen as insignificant and thus hardly mentioned. As emphasised by this Danish physicist this may, paradoxically, be because Protestantism is considered more 'tolerant' than Catholicism:

> P30, M, DK: *The fact that Denmark is a Scandinavian country has great significance. A Protestant country can take many different shapes. If you look at it from a religious point of view, then you would be inclined to say that we as Protestants are very tolerant as supposed to fundamentalist Catholics. (…) I think of the Scandinavian version of Protestantism where religion is more of a private matter, something you define for yourself; there is somehow more room for a discipline like physic, which deals with terminology which is very far removed from that of religion. In Denmark, you don't have to argue with people whether the world was created in six days or not. Religion stays out of that, mostly.*

Both Danish, Finnish and Estonian physicists see religion as a marginal factor in society, with very limited influence on politics and other social areas. Moreover, in our contrasting analysis of the data material we see that the Nordic UPGEM researchers seemingly do not attribute this theme much importance as they rarely probe into the issue.

In the Catholic UPGEM countries, religion is often connected with fixed concepts of gender. An Italian female physicist thus emphasises the role played by the Church for women's way into science:

> P73, F, IT: *In a Protestant society there is also a particular family structure, but I do think that the Catholic Church is one of the reasons why women in Italy, in Latin countries, had an easier access to science, because Catholic Church used to have convents, where women were being educated. The negative side of Protestantism [is that] they closed convents in England, used the money for English Universities, but women were not admitted to Universities, so in Protestant countries women lost places for a higher*

> *education, while in Catholic countries this education continued in France, in Italy, in Spain. So the Church had a very important role for women's education, even if someone might say that we don't have a female Pope, female priests, but still women got educated and admitted to Universities, because one should remember that in 1700 in Italy there were female professors, not many but still, so the Church had both its positive and negative influence.*

In Poland the influence of the Catholic Church is seen as having more a direct impact on women's career paths.

> P90, M, PL: *It continues to be the case that a woman keeps house and looks after children, and any more professional career is disapproved by many people.*
> Interviewer: *There is such a stereotype in Catholic countries?*
> P90, M, PL: *Yes, there is.*
> Interviewer: *And what consequences does it have?*
> P90, M, PL: *Well, the consequences for women are that it's much harder for them to achieve professional success, for instance, in science. Not only in science, but science, and especially physics, is perceived as a typical male profession.*

However, the most common connection is between Catholic religion and family life. The image of 'the holy family' generally affects not only on the concept of family but also on many other aspects of everyday life. Several of our Italian and Polish physicists find religion has some impact on their family life, though many also find the opposite; that religion is not a very influential factor. Nevertheless, taking the wider cultural context into consideration, we know from history that the Church has always had indirect influence on society, especially in relation to gendered subjects. Likewise, our Catholic informants mention a number of consequences of the indirect influences of the Church on society and family policy. These, for instance, include the absence of sexual education in schools, edicts concerning the use of contraception and having abortions and the woman as caretaker of the family etc. In answering the question *Do you think it*

can influence physics that you live in a Catholic/Protestant country? Either in relation to conceptions of physics or in relation to conceptions of family[26] Catholicism was pointed to as an explanation for some public patterns:

> P39, M, IT: *Absolutely, and I know it from my personal experience, my sister, being catholic, is really suffering from the fact that she has a child and is divorced, so it does influence a lot, also after having lived in Finland I can draw a comparison, and they have a totally different perception.*
>
> P41, M, IT: *[I]f you live in Italy it is better to get married, because in this way the other person is protected. De facto couples are not considered.*

In fact, our Catholic physicists do not doubt that, in some way, religion has an impact on the moral principles and family patterns of the Catholic countries.

> P58, F, IT: *Catholic religion influences many aspects of life because in Italy we have this idea of the family in which women play an important role, a central role in children's upbringing, so, even if you are not a church-goer, a lot of expectations lie on a woman, and they lead you to take unconscious decisions, and you, as a woman, feel guilty if you have not been the right mother for your children, a mother who is always behind them because religion teaches that the woman's main role is bringing up her children. So, Catholic religion absolutely influenced my life.*
>
> P134, F, PL: *In Poland, when I take a look at my older colleagues, then Professor [X] happens to go abroad a little, well, so this marriage of his, he doesn't speak best about it. Generally, actually the family is in the second place, in the first place there is work. Of*

[26] This question about religion in relation to science and family was included in UPGEM interview guide (Hasse, Sinding and Trentemøller 2008a, 376).

course he is with his wife, he is a great Catholic, so he would not divorce for anything on Earth, but simply, in the first place there is work, then there is the family.

P44, F, IT: *I went to France to abort and from what I heard, also from people who had their abortion in Italy, for sure my, my experience was much better than theirs, because I did it in France, you see? So, unfortunately, Italy is a country where, hum where the Church has a negative influence and so, many things – you know (...) we lack the information, and so people get scared, they are afraid also because they hear many silly things, it's rubbish (...).*

3.4 Summing up

In this chapter, we have worked our way through a number of seemingly unconnected contrasts between cultural models of the classical physicist, family life including motherhood *versus* parenthood, and the interplay of religion, gender and science. The cultural connections which we have learned to make in one national context, and which are self-evident to people from this context, appear highly controversial to people who have learned to make other connections in another national context.

As mentioned at the beginning of this chapter, the cultural models we have discussed have not been generated within physics *as* culture. From the point of view of Traweek, who talks of physics as an isolated culture of no culture (Traweek 1988), we can define these models as generated 'outside' physics *as* culture. Though we have found many interesting and new findings of the relationships between gender and physics, the different cultural models embedded in each of their national context cannot explain why we find a diverging proportion of women in physics across the nations in UPGEM. We re-address these findings in Chapter 7 in a discussion of how the nationally formed cultural historical processes may shape different possibilities for careers for women within the physics activity. The combination of the cultural models identified in physics *in* culture (i.e. classical physicist, family life and the interplay

with religion) with our analysis of physics *as* culture (i.e. the three ideal type cultures Hercules, Caretakers and Worker Bees) will provide us with a better understanding of the proportionally higher number of female physicists (many of whom are mother stayers) in Italy and Poland.

4.0 Physics *as* Culture: Hercules, Caretakers and Worker Bees

In the previous chapter on physics *in* culture, we have explored the activity of physics as embedded in national cultures. From this perspective inclusions and exclusions from the activity of physics are taking place as a consequence of factors external to the activity of physics and the way it is practiced at universities as workplaces. When we take physics *as* culture as our point of departure, figurative landscapes can be drawn and contrasted. The activity system and its expansive learning processes may be influenced by national cultural historical processes, which enter physics activity through multiple mediations in activity (Engeström 1990, 79) or through adjacent activity systems (Engeström 1987); but, they can also be viewed as one activity. In many ways, physicists use the same tools to reach the same object of new knowledge through research. Their community systems generate more or less similar divisions of labour between the different members of the community (e.g. the professors, associate professors, and Ph.D.s). Though they operate within different fields of physics and use different types of instruments, all belong more of less to the same 'epistemic culture' (Knorr-Cetina 1999). We could have made a more traditional activity theoretical analysis (see for example Engeström, Miettinen and Punamäki 1999) following "the object-oriented and artefact-mediated collective activity system as the prime unit of analysis" (Engeström 1999). The activity of the physicists could, in spite of national borders, be viewed as one activity where inclusion and exclusion in the activity could be argued to stem from "historically evolving inner contradictions in activities" (Engeström 1999). Instead of contrasting physicists in different cultures, e.g. Italian with Finnish physicists, we have, by searching the entire database for information on physics *as* culture (excluding gender, nationality, position or age), looked at clusters of connections in the physics activity and thereby explored the notion of a culture of no culture.

When our analysis moved 'inside' the activity, we found that in the cross-cultural activity of physicists, selection mechanisms were explained

by contrasting clusters of connections (formed in activity). Inner contradictions are not solved by an expansion of the activity, as in Engeström's argument for expansive learning in activities (Engeström 1987), but through the mechanisms of inclusion and exclusion of members.

In order to interpret the statements from our informants across national cultures in relation to the cultural models found in the activity, we looked to Max Weber's notion of ideal types (Weber 1905) and adjusted the concept to fit the purpose. In our analysis, an ideal type emerge in the identification of salient connections (forming cultural models), which can be contrasted with other salient connections (other cultural models) found in the empirical data material. From these cultural models, we form clusters of cultural models in our analysis, and they function as the framework for inclusion and exclusion in activities. These frameworks, or ideal type cultures, are not specific for any particular case in the interview data. The ideal types are a synthesis of the ideal clusters of cultural models, which is used as a coherent frame in the given culture for better understanding statements about universities as workplaces. In this particular cultural framework, ideal cultural types of physicist will mean a one-sided accentuation of particular connections found across the whole of the UPGEM database pointing to how one should act ideally in this particular culture. The ideal types are meant as a tool to identify salient characteristics in scientific cultures. Within each culture, the directive force of the organization of cultural knowledge about how best to act in everyday life as a physicist forms the three different salient ideal types in physics *as* culture. We have named the three scientific cultures Hercules, the Caretakers and the Worker Bees. As tools of analysis the three ideal type cultures become our, the researchers', etic categorizations.

It is important to stress, that the three cultures, identified as ideal types, do not refer to particular physicists, they are clusters of connections, which form cultural models. Our three ideal types also represent models for how you can be recognised as a physicist in physics *as* culture. Through the ideal types of cultures it is possible to analyse certain statements from the physicists as reactions to a particular cultural model for what is considered 'the ideal physicist' in the given workplace environment. Though we ground the ideal types in

the informants' real life statements, we do not claim that any of the interviewed physicists are personifications of either of the ideal types. They function as analytical constructions, which make it possible for us to identify contrasts in the empirical material.

The ideal types found across the data material can be argued to shape a more or less salient cultural context, which directs the motivation of physicists engaged in everyday life activities. We find that some statements can be explained as reactions to a cultural context, which force physicists to leave or to feel dissatisfied. We also find that what is considered admirable and innovative in one ideal type culture might be regarded rebellious in another. Though we find Hercules types, Caretaker and Worker Bee physicists throughout the material, we also find cases of informants working in a cultural context that is predominantly influenced by e.g. Herculean connections. In such cases, we call it a Hercules culture (and if a given culture has predominant Caretaker or Worker Bee connections, we call it a Caretaker or Worker Bee culture, respectively). Thereby, career paths of female and male physicists could also be argued to be influenced by the particular ideal type that is most salient in e.g. the national context.

4.1 The three scientific cultures

The clusters of connections that have been contrasted to identify the three ideal type cultures concern the relation to the innovative, diligent and responsible work as a physicist, the sense of workplace identity, the attitude towards competition, the perception of power relations at the workplace and finally the position of gender in workplace relations (see Figure VI). It is important to note that all three ideal types and their associated characteristics are equally important to any physics environment.

Figure VI *Directive force in the three ideal type scientific cultures*

Cultural models:	**HERCULES**	**CARETAKERS**	**WORKER BEES**
Work relation	Physics is the only thing	Physics is everything but must be socially acceptable	Physics is not everything in their life
Workplace Identity	Focus is on ego	Focus is on the group	Focus is on the task and family and friends
Competition	1-on-1 fights using all means available	Group versus group	Uninterested in competition
Power relations	Anti-authoritarian with hidden power games	The group requires young members work their way up	Formal hierarchy
Gender in the cultural models:	**HERCULES**	**CARETAKERS**	**WORKER BEES**
Gender	Used as a negative element e.g. in competition	Acceptance of gender roles in relation to groups and not used negatively e.g. in competition	Not used negatively in e.g. competition

In physics *as* culture, three types are needed though not always recognized. This can cause tensions – and in some contexts, connections from one of the ideal type cultures may be so valued that it forces physicists from either of the two other ideal type cultures to leave the given physics environment. In practice, we never find a 'pure' ideal type person. Instead, we find 'split' personalities in the sense that, in one sentence, the interviewed physicists may express values that we have categorised as Worker Bee as well as values that are associated with the Caretaker culture. Even so, the data material holds examples of real life people whose scientific life stories have an inclination towards a primarily Hercules, Caretaker or Worker Bee career path.

Though all the informants in the interview material have, as a minimum, commenced a career in physics by embarking on a Ph.D., some of the quotes in the material below come from leavers, i.e. physicists who are no longer part of physics *as* culture. In so far that they think back on their time in physics – or if we find a statement, which we believe is characteristic of one of the ideal types, we have used these quotes regardless of whether the physicists are still active in physics *as* culture. Sometimes our informants think back on historic periods of time, which are now long gone – such as the Soviet period. If such statements contribute to the identification of the ideal type culture, we have included them in the cultural model.

Many of the connections constituting the three ideal type characteristics are likely to reflect researchers in academia in general or even people working in any type of workplace. As we have not contrasted our material on physics with data from other fields, we cannot know to what extent they reflect researchers in other disciplines. But when we look at the challenges that our researchers in physicists face in their everyday working life, which is different from our experience as humanists, e.g. working in big groups, demands for going abroad, lab work, these are more likely to be particular for the field of physics *as* culture.

Though these features run across all cultural boundaries, we have here chosen to concentrate on physics *as* culture as the subdivision of three ideal clusters of cultural models. Contrary to the connections found in the previous chapter on physics *in* culture, where e.g. more general national concepts of family life were discussed, we shall here concentrate narrowly on connections made to physics activity in the data material. It is not so that all quotes in our data material can be placed under the heading of one of the three ideal types. In some cases the informants' statements overlap two ideal types and can be placed in two different ideal types. Other statements may refer to some aspect, which we consider to be a particular ideal type, whereas the utterance in itself could be seen as confirming another ideal type.

Sometimes the ideal type can be found directly in the quotes, sometimes we find ideal types, when the physicists refer to other physicists, and their description fits our understanding of the ideal type.

The latter case can be expanded to physicists reacting to, what they consider a norm in their environment. Even when they do not refer to actual people, but to generalized norms and values, we take these values to be expressions of an ideal type cluster, which provoke reactions from physicists who happen to disagree. Furthermore, in our analysis the reaction is a contrast clash between ideal types.

The ideal types are analytical constructions, which constitute a measuring stick for the researcher against which you can detect equality and dissimilarity in particular cases which then become comparable. The ideal type never appears in real life, and would not be recognized as a 'typical' person, nor does it bear any statistical features. The ideal type accentuates what the researcher sees as salient collective connections and mindsets rather than individual traits.

In our case, the ideal types are constructed by piecing together our general analysis of the empirical quotes which we find can form a logically consistent whole against which, we can measure our analysis of empirical data. As in the above case, we mostly identify Hercules types in the stories told by others – as Hercules is often either admired or hated for his or her innovative thinking and pushy qualities. All across the data material, we found that the physicists' approach to work place activities could be contrasted. Statements can even be identified in contrasting a 'Worker Bee statement' with a 'Hercules statement' or both of these with a 'Caretaker statement'. In this case they are perceived as reactions to the prototypical connections of a workplace culture. We see reactions, which tell us how one should not be in one of the particular cultural context: Hercules culture, the Caretaker culture and the Worker Bee culture.

For analytical purposes, we have not listed the nationality of the informants quoted in Chapter 4–6 as we wish to ensure that their statements are read as illustrations of ideal type physicists in ideal type cultures and not as 'real life' physicist representing specific nationalities. When statements are quotations from one of the other UPGEM publications we have listed the nationality as it is already identifiable in the reference. We return to the question of national culture in relation to the ideal type scientific cultures in Chapter 7.

4.2 Hercules: The Physicist Fighter

This ideal type of a physicist is inspired by the Greek hero Hercules. Though the Greek Hercules might not call forward all the connections tied to our Hercules physicist, we chose this name because it carries connotation of an individual fighter, who never gives up, who is always engaged in a struggle, who is completely devoted to his labour and who strives for immortal fame. The characteristics of our Hercules physicist are, apart from the above, a dominant behaviour, extreme intelligence, high international scientific ambitions, love and devotion for physics research, perseverance, a creative and innovative approach to physics, self-confidence and not least a very competitive approach. Our ideal type will fight for fame with any means he finds on his way and can be extremely manipulative, arrogant and can be very daring both when trying to win competitions and when trying to make innovative research. Physics is his entire world and it is here he seeks his victories and risks defeat. He is scornful of the public concern for how physics inventions could be misused in a harmful manner.

It is our argument that these values are to be found as cultural models for how to act as physicists throughout the physics community (as it is represented in the more than 16,000 quotes in our interview material). When clustered into an ideal type the cultural models form the cultural work place values, which an individual physicist relates to when they praise or denigrate colleagues and place their own behaviour in relation to colleagues, the discipline of physics and the workplace practice.

Though our ideal types are not gendered, nonetheless we refer to the Hercules as a ‘he’ for two reasons; first because ‘he’ (in contrast to Caretakers and Worker Bees) is identified and referred to as an individual person, and secondly because the character who lends us his name is a very masculine figure. Even so, it is important to underline that though most of the quotes we use stem from male informants we have also found a few female typical Hercules quotes in our research material.

4.2.1 Relation to physics

Being passionate about physics is *not* a characteristic of only the Hercules. In fact, we found this to be one of the most salient connections across the whole data material. Most physicists, even those who left, express passion for their work (see also *Draw the Line!*) as for example this physicist:

> P118, F*: I admire the enthusiasts, who really do something with passion and who can pass that passion to others. I think it is an important characteristic for another man. It is known that a physicist has to be intelligent, wise and so on. But the best thing is his passion and belief in what he does. This is generally the finest virtue of the physicists.*

However, for some physicists work with physics seemed to be a passion, which overrules all other relations including social relations. This is a characteristic of Hercules. It manifests itself in two ways, which, though they seem almost opposite, are in fact connected: one is the nerd who shuns human society. The other is the charismatic type who seems very engaged in social life – but who in fact only engages in human relations, when it can be used to develop his status in physics. What connects both is that they engage passionately in physics and will not allow any social obligations to stand in the way of this interest. They detest small talk and prefer to talk about physics all the time.

> P190, F*: [H]e, like, does not participate in social things when, let's say, someone has a birthday and the entire lab sits together after work and drinks coffee, he will disappear quietly and you can soon hear the key board, he's sitting at the computer and calculating. Or, when there are some festivities or someone has a jubilee, or, he doesn't have this social chatting or this empty talk, he doesn't do that, he is bored there and he is not ashamed to walk away. Or, let's say, at the lunch table, right, when people are done eating, they talk about cats or birds or, for quite a long time, well, that's okay,*

sometimes it's nice to just talk, but he takes his dishes away and goes and continues working.

A physicist explains the salience of work in relation to social engagement at the workplace in describing his colleagues:

P9, M: *Many of them are nerds. Maybe I am myself too. Probably I am. But many of them have [pause] the science as number one. It is everything to them. They are completely dedicated to what they do. (...)There are a lot of people at the Christmas lunch who do not drink at all. This is an example of how special the work environment is. You are at a Christmas lunch and then a lot of people go to work afterwards. They actually go back to work afterwards. They have a Christmas lunch that begins at two o'clock and they are drinking mineral water, then they go back upstairs and work until nine. That is like the one I mentioned. He does not like to drink because he does not like losing control with his head. There are a lot of those. You have to respect that, but it is special.*

That a Hercules will not loose control, but live for his work, does not mean that he is solemn – in fact, it is another characteristic of Hercules that he can be very playful, creative and innovative and have an almost childlike playful attitude to physics work, because it interests him so much – but in a rather egoistic manner:

P167, M: *Even though they were not young boys anymore, they were still so immensely interested in it and somehow very fresh in the work that they did.*

P35, F: *Yes, they are actually a bit childish. Because they are running their own show, they are not so dependent on each other. So they do not have to care that much.*

Doing physics is *"[e]xclusively because it is fun and interesting. That is the only thing. (...) I think it is extremely fun. I mean, all the time I decide what we are doing here. I always know what the most fun things*

in here are. This is just fun. Curiosity and it is fun and exciting and we make a lot of crazy models" (P1, M).

Physics is so much fun, that "*I would not even define it as work!*" says P38 (F).

Playing around is not just to make fun but in the end for the benefit of physics:

> P1, M: *We make [our research] through fun and seriousness (...) it is the same thing [laughing]. It goes hand in hand. That is fun about what inspiration makes us think about.*

Only science (and having fun with science) matters, not money or stability in the work life:

> P1, M: *Seeing that I am doing what I want to do, I am satisfied. Of course, I would like to earn a bigger amount. Seeing that all the people in my neighbourhood are probably getting twice as much as I am, but then again, they are probably doing some stupid and boring kind of work.*

In a Hercules culture, it is more important to be able to formulate new questions than it is to be able to answer questions posed by others. In this sense, Hercules is innovative, as he will turn things up side down to find new questions. The draw back of Hercules' disinterest in finding answers to questions already posed by others is two fold. Firstly, he will not work meticulously on the more detailed aspects of finding answers. Secondly, questions for example of new members of the community will not be answered which will lead to information, which creates different levels of membership.

> P32, M: *When you reach this high [from Ph.D. to a permanent position], you have to define a direction yourself. So you have to be good at asking the right questions, rather than being good at answering them. And it makes an immense difference.(...)So there is a quite clear division line here, were you go from, somehow on an*

> *increasingly higher level, working with subjects that others have defined, but you have to sort of fill out the frames. Here you have to SET the frames.*

It is a typical feature of Hercules in his relation to the work in physics that he never cares about the work hours and is willing to work at night. This he can manage because he has a family, who takes care of the home, while he is working:

> P5, M: *My wife is rather magnanimous in that respect [that she takes care of the home, while the informant is working] and I try not to take advantage of that. But if you are very ambitious – I leave at 5 nearly every day and that is my choice. You might want to finish things off before you leave and stay until 20.00. I only do that on very rare occasions. I don't feel that there is a conflict there. As I said, my wife is very tolerant also with respect to business trips, she doesn't consider being alone with all responsibilities at home a problem.*

> P34, F: *What was the best thing [about my colleagues in physics was] the commitment to it (...) that they also stayed in the evening and half the night if we needed to make it work. And we struggled to make the equipment work. People did not just go home at three. (...) It seemed like some people seemed to have the wife to take care of the family and the home, and you could see that they were the ones presenting the best research results.*

Thus in a Hercules culture, where long work hours are needed and a lot of travelling abroad, you need a wife at home or give up having a family:

> P174, F: *My supervisor keeps telling [me] that having a private life is not necessary. That you should work 12 hours a day and then some at home and then 6 hours on Saturdays.*

> P37, M: *I think I might have mentioned it already: he works 4 days and 3 days he stays at home, and when he works he is at the peak that is 3600 meters high in the observatory and sleeps on a folding be (...) It is true that in order to do science to this extent the private life should be sacrificed. (...) We are talking about passion without consideration of the working hours or other things.*

A real Hercules hates everything that will take his time away from physics, including teaching and administrative work. He has no patience with bureaucrats – he wants work to be the sole purpose of research. In this work place culture there is a hierarchy of tasks:

> P6, M: *The research is in the top, and then teaching and then administration.*

The scientists *"put passion in front instead of organisation and technology"* (P1, M), but they are met with demands from bureaucrats.

> P1, M: *But I am not that much of an optimist in this area, I mean in regard to "leave us alone, and let us do what needs to be done".(...) You could argue that you ought to fire all the bureaucrats, but that is not really [unclear].*

As Hercules devotes him or herself so much to work, the academic world is like a closed bubble around him. In this culture, you draw attention to yourself as "*inveterate physicists, we think that everything is physics. There is physics behind everything in the real world"* (P6, M). The academic world is the only place considered worth being – and it is "*unseen that you leave the academic world. If you leave your back to the academic world then you indicate that you have other interest besides the academic world and that is very unwelcome. You don't do that. You have to sacrifice your whole life to the academic world if you are in the academic world*" (P12, M).

All that counts is you in relation to the world of physics. What matters is that physics is fun to do, and not necessarily, that it is useful:

P17, M: *You can say that the things I have worked with have always been things that were – they were not useful in a narrow societal sense, not something that leads to great inventions or anything, but instead it has developed our more basic understanding of natural forces and how the universe works and all the fun questions which everyone wants an answer to, and that is why they are so much fun to work with. So it has not so much been to make a difference, but more because I though it was interesting.*

4.2.2 Workplace identity

A Hercules must have a lot of self-confidence, because he must convince others that he is the best, when he fights for recognition:

P36, M: *Oh yes, there is a lot of competition. This whole process is extremely competitive. The case that the department needs to make to the university is that I am not only good enough for the job, but I am the best person in the world for this job.*

Therefore in a Hercules culture one has to "*beat anyone, but to prove being the best*" (P37, M). The following portrait presents a set of typical Hercules connections:

P32, M: *(...) He was the only one at the institute with enough spirit and elbow grease. And when you spoke to him, he was always trying to take down someone, or attack someone. Then suddenly, it gets really funny. Or you counterattack. It's just his form, and sometimes it tiring. But he's also the one, when someone speaks of something it gets terrible theoretical, and terribly complex, and it leaves you completely intimidated because of all the pretty words you've never heard before. This guy is the only one who is skilled and bold enough to say: "I don't understand a damn thing of what you're saying, explain it so I can." He dares. And he is skilled enough to do it. He is liberating. All the dust is blown away, and you get to a level of talking about something concrete. And he simply loves being*

> *clever as a fox and provoke people in any way he can. It's just him. And if you can take it it's quite amusing, but if you can't it's probably very unpleasant.*

A Hercules will also stress that his qualities as a scientist are inborn:

> P17, M: *It has probably always been in me since I was a child that this was fun and I would like to do this. So it was always very natural.*

Even though a playful attitude is part of a Hercules ideal the driving force is scientific ambition – even if it means a lonely fight until he gets the recognition he wants. Though the world does not believe in him, he is confident of his ability to win in the end and willing to take chances. He is even willing to risk being perceived as a failure, because he expects to triumph in the end:

> P36, M: *[H]ow [can] you do something new and go against the current and do something that has not been done before? People may even be saying that that probably is not possible, or "you cannot do that, it is too hard" or something like that. Some of my colleagues have done things that they initially got negative feedback for, and I learned from that when my own experiment initially was not funded, and I was told by people that it was too ambitious, it would not work. I would not be able to get it done in any time in fashion with the money I was asking for. And they were not going to give me more. Even the person, who ended up giving me the money. When I presented my first results, he came by and he said "I never thought you would do it, I did not think it was possible but we figured, we will give this guy a try".*

He is daring because he knows that this is connected to being creative in rethinking physics. This and his anti-authoritarian tendencies are what make him endure the hardship of being ridiculed by equally competitive competitors, who will try to make him look like a fool to win the competition themselves.

> P196, M: *[W]ith every new idea I risk my being in this very same [physicist] society, I risk getting expelled, risk getting ridiculed, risk getting fired. I mean, that I start telling silly things. (...)[E]very time I dare think something new, I become a target. It's a lot easier to say "well, I had an idea, but it was just an idea" and see that it is in coherence with the trends and in coherence with the financers. (...) [I]t can also bring about a complete failure and sometimes it also does, that's also a risk. That's a creative risk, right, that I risk. (...) It may prove to be lame and it may appear that it's nothing, there's still that danger, but I dare take risks. I will not bootlick [any superiors]. I say, to the hell with all that, and I again risk the possible unemployment and lack of money, but I just take that risk. I'm the kind of person that takes risks, right. That's what I want to say.*

In this ideal type culture, we find Hercules types (male and female) who concentrate on their careers and demand that everyone devote themselves as much to work as they do. They can be perceived as brilliant but also as having a big ego, which is consequently annoying.

> P156, F: *[T]here's a person who's – [My colleague] is a professor nowadays and a very successful scientist, but [this person] did have quite an ego, concentrating on his/her own career. It didn't really affect me negatively, but I just don't have the patience for that kind of thing. [This colleague] has his/her own merits, but…it was more like: "I've worked here for fifteen years, so everybody else should work here fifteen years too", and he/she knew everything about everything, how everything should be done.*

Often other people admire Hercules for his intelligence – and, if he is not the nerdy isolated Hercules, he is sunning himself in the admiration of others and makes sure to let others see that he acknowledges his own superiority – most often in a polite manner. One informant tells us of a lecture by a famous physicist "*during which he – well, let's say that, that a person points out in a friendly way how much he is superior to all his listeners. Precisely in a friendly manner, not humiliating his audience"* (P206, M).

The physicist writes four exercises on the blackboard, and explains that it is one for the students, one for the doctoral students, one for research associates and finally an exercise for the professors present.

> P206, M: *And after that our professors sneaked out quietly because they didn't know how to solve this exercise. (...) I mean, being intellectually superior and at the same time not humiliating those who are inferior.*

In a Hercules culture everyone must constantly either invite to or be prepared for scientific 'duels', where they must defeat the challenger – or find a dexterous way out of the coming defeat. Whatever they do, they must avoid revealing a lack of scientific ability. In this case, it is a Hercules meeting with other Hercules professors. The challenger marks a duel with his acts of superiority (giving the professors exercises) and this is inevitably read as an attack on the other Hercules' self esteem and led to frustration because they cannot answer the challenge and win. In this case, the professors chose to sneak out because they understood that they otherwise would be revealed as less capable scientists – and thereby publicly show that they were not as intelligent as the challenger.

> P206, M: *Well, no, they still – let's say that their world view presupposed that they were like – let's say that in their institutions they were superior to others and the fact that they were forced to admit that they won't solve this exercise very quickly made them feel frustrated.*

4.2.3 Competition

In a culture where Hercules features constitute the ideal, it is commonly acknowledged that the cultural model of competition connects competition with being an individual fighter against your individual colleagues:

> F, DK: *[I]t's everybody against everybody and you therefore have to think very strategically and notice what your colleagues do and*

> *what it means when they do this and that and what sort of hidden ulterior motive they have when they do so and so. And that's a bit hard but that's the way it is.*
> (Hasse, Sinding and Trentemøller 2008b, 78)

Hercules's conviction of being the best (which is a must for survivors in a Hercules culture) can amount to arrogance whereby the (perceived) intellectual superiority is turned to a disdain for others:

> P149, M: *Most of the physicists I know are pretty arrogant.(…) it's just – when you're the best it's just (...).You understand things better than other people.*

In cultures where Hercules has free rein, he may develop a dark side, which involves harassing and mocking other people**.**

> P206, M: *[I]t depends on the culture of the specific research institution or area or organisation, how the competition is realised or what kinds of methods are used. (…) [I]n the [former period] inferiors were downright mocked sometimes.*

In a Hercules culture, it is natural that everyone wants to come first with results, and you also fight for funding, positions etc.

> P17, M: *Yes and no, I mean yes of course there is some competition, because everyone wants to come first with something interesting, and it is always very annoying if others have suddenly published an article on the topic, on which you only had two weeks work left or something like that. And there is of course also competition in that there are limited financial funds for far too many applicants, in different contexts about money, so in that sense there is also competition.*

Hercules functions equally well with open and hidden competitions, because he, due to his characteristics, can play the game and steal results from his colleagues without feeling remorse; he will always

believe he has the right to these results because he believes he can make better use of them than his colleagues.

> F, DK: *Well ugly things may happen there, when people steal each other's ideas […]It's not very nice. You know who it is, but still they are allowed to run around out there.*
> (Hasse, Sinding and Trentemøller 2008b, 77)

> P47, M: *Anyway, it may happen that one of your colleagues steals your data. (...) [The] data may be published. Therefore, the first one to publish them receives recognition, whereas the second one isn't published. (...) [T]herefore, in this context there may be sharks and researchers competing with each other to publish their studies. You need to be a shark.*

If colleagues signal that they are in doubt about their devotion to physics, the Hercules types could be compared to a vulture, and they are ready to devour the other. In this world, the Hercules types are willing to fight to get the best possible position to do the work – and they fights with all available means.

> P12, M: *Some of those TV-series, what are they called, the Robinson Island [i.e. Survivor] where everyone is fighting everyone that's kid stuff compared to how the assistant professors fight each other with pointy elbows, intrigues and diverse strategies about the ones with power*

> F, DK: *You spend a lot of energy on fighting the others and move yourself forwards.*
> (Hasse, Sinding and Trentemøller 2008b, 74 + 120)

However, the main thing you fight about is on a more subtle level than positions, funding and higher salary. Basically, it is a fight for being recognized as 'the best' or even better 'a genius'. You have to be (or pretend to be) intelligent, important, creative and brilliant. It is an acknowledged value that all must strive to get to the top and never be

satisfied. Even when a Hercules reaches the top in a local physics environment, he will always look for wider international fame. Hercules knows that only a few get to the top and acknowledges that he has to fight and go on fighting. Even so, he might leave, if he understands he will never be part of the elite in this environment. Accepting being number two is not an option for Hercules and those who seem to accept this position are looked down upon.

> P32, M: *[T]hey [less ambitious colleagues] are missing students because their work is so unimportant. And then there are some who shine – very, very few. VERY few, who had some extraordinary talent for seeing what is exciting.*

> P33, F: *I thought; OK this is really impressive. Small geniuses; perhaps the best in the world in their small field.*

> P35, F: *And then he [the supervisor] had difficulties understanding (...), that other people he has had as PhD students, they finished their PhD and then they 'only became high school teachers' [she is referring to the supervisor's reaction]*.
> Interviewer: *That was not so good?*
> P35, F: *No, that was just not ambitious enough.*

Though everyone in a Hercules culture understands the more obvious things people fight about, the means to win competitions and success are not clear to everybody. A Hercules is a fast learner when it comes to detecting what is 'written between the lines' in the scientific culture – and in a Hercules culture the most important lesson to learn is that you must form strategic alliances with the 'right people'. As this cultural knowledge is not an explicit part of the taught curriculum, it is not an insight shared by everyone. In the case below, the physicist has learned how to fight, but discovered too late that the ones she formed alliances with were too weak.

> P4, F: *I would describe it in the way that there are a number of senior employees and you need to build up alliances. And if you*

> *makes alliances with people without the necessary power or people who loose power or in the particular instance when you need him or her do not win, then you will not get your position. So you mentor's position of power at the crucial point is decisive for the elimination mechanism. So you need people who are willing to stand up for you, who have political flair and who by incident happen to be in the position of power at the given time. And my mentors' positions at the time were not the best.*

Those who have found out how the system works can be either compliant (even 'sucking' up to powerful people) or present themselves as fighting back like a 'lonesome fighter', which is a quality that is also admired in the system.

> P12, M: *[T]here is an alarming high degree of nepotism in this system. And it's all about having the right connections. Because many of the researchers who get to the point where they have gotten money from the state's scientific research committee they have proved that they are competent. And what decides the final call is based on who you are friends with or not. And it is no secret that this can create many problems for people like [this colleague of mine] who is a great guy, extremely intelligent and very competent, but he is very political incorrect. He says all the things, which we only think of, but in some situations he should have shut up. So one can create problems for himself by backing the wrong horse and not cooperating with the people who sit in the right committees.*

Though this colleague is not politically correct he is, in the end, more likely to win (power, positions etc.) than colleagues, who try to play the game, but are not good enough because he shows the Herculean will to fight – also openly if needed. This fighting spirit of doing it on your own will eventually be recognized by a powerful Hercules on the top. The individual bond between the lonesome fighter and the Hercules on the top then paves the way for a new powerful Hercules. Here a Hercules looks back on his meeting with his powerful Hercules mentor:

> P36, M: *[H]e asked me, "where do you want to be in five years?", a typical question you ask at a job interview. And I said, "I want to be an independent scientist running my own experiment, maybe a professor at a university doing research on my own. Being the boss of something, being" I told him, "someone like you. That is what I want to be". And I was telling the truth.*

Because Hercules is a loner and a fighter, he might find submission to group work problematic. He will rather fight than share:

> P35, F: *[I]t is always about how you communicate it, how do you promote yourself, how do you sell the message and make people interested. I know I have to affect some of the old men and their thinking. And they will still have these elbows, and will not be able to see that we should share this, let us share the ideas, and then we could do it even better.*

People manoeuvring in a Hercules culture, who do not recognize the competitive environment or notice the hidden rules of the competition too late, face the biggest problems.

> P31, F: *You are so far a long before you even notice it (...). You would be a couple of years down the line before you really noticed who it would be good to know.*

But even when people recognize the manoeuvres in the 'murky waters' and that there hidden rules for how you have to operate in to be successful, you might fail, because you try to impress in a manner, which is not the 'right' one in a Hercules culture:

> P4, F: *Yes I did. I knew it and I also tried to form alliances with the last player but did not feel that I was allowed inside. I did not succeed in forming the alliance; I tried to go about it so that I could be covered by this last player so that I could be the favoured candidate with all members of the committee.*
> Interviewer: *How do you do that?*

> P4, F: *Conduct collaborative research, have scientific ideas, participate in their research, make suggestions for collaborative research. In that way you try to build the foundation for the sandcastle, try to imagine the sandbox already containing five or six castles. You can easily work side by side but you do not necessarily participate in building all five castles at the same time but you need to assist in building some of those that are important to the project as a unity. So participate in the important projects. (...) [For]Two reasons: to prove that you are good and to make yourself useful to other people's research. If they can see an advantage for their scientific career in you co-producing their results, if they gain from your work, then they have a strategic need for your work. You become an asset to the group in proving their need for more funding.*

In a Hercules culture, it is not the way to fame and power to help others and rely on collaborative research. It is much more important that you prove yourself creative, innovative and a challenge to physics research – and ensure that one's effort is recognized by those in power. What counts in a Hercules culture is the ability to make powerful individual people believe in you. In the Hercules culture, loyalty to the members of the groups one works is not necessary, only loyalty to the people who can help your career along.

> P12, M: *There was a professor who has just retired. And he was a great guiding principle for me. I met him for the first time at a conference in 1994, back when I was a PhD. student and we discussed points of view on research and we quickly became good friends and he invited me to the university in [X] and I went there a couple of times and later I got a job there as a post doc. when I finished my PhD and I worked there for three years. I often consulted him and that has been a big help for me and he has opened many doors for me. And, as I said earlier, it helps to know the right people who have some power.*

The best and most successful Hercules types understand that to reach the top they need a network that allows them to draw on a number of

powerful people, and to move on to another when their ability to help them getting further ahead is drained.

> P36, M: *Yes, I think mentoring is incredibly important in science and I have had many mentors actually. A guy who taught the course in [my field of] physics was a mentor of mine. He helped me get the position at yet and I ended up doing my Master's thesis project (...) not with him as my advisor, but he made connections for me. And I had good mentors at [X], who (...) were helpful in not just the thesis, but also helped me write good recommendations for my applications for an [international] PhD programme. Because I at some point came to the conclusion that I wanted to study [internationally] at the PhD level. They offered me to work [at the institute] and do my PhD. [at the institute], but I found that [going abroad] was something that I would really benefit from. (...)And they wrote recommendation letters for me, and that helped me get into [an international programme] where I ended up doing my PhD.*

The successful Hercules will often surpass his mentors and 'elbowing' is often used by the less successful as a description of how Hercules climb the ladder:

> P132, M: *That very MSc student of mine is a good example; she has a full professorship; she has fantastic contacts with [a colleague]. She participates in the international grants, mainly the American ones. So she is getting along well, fantastic, and I don't think that gender would be any kind of an obstacle for her. She simply worked on it, she was able to work on it, to elbow her way in science a bit, to do good work, so that they noticed her [internationally].*

The cunning element of his way of thinking will make him spend time on networking if he can see that a given network can benefit his cause. He will succeed in making other skilled physicists support him, but he will not spend time on the more peripheral or upcoming physicists.

> P1, M: *[W]hat you get on the post doc is the essential contracts. You can built a network and learn – get a feeling about – changing fields and get a feeling about something new than what you have done previously. You can lose that and that makes you less appealing at the next step. You can get it in other ways, but it requires that you are much more open and extroverted. You have to go abroad and be really competent socially or very accomplished in your subject, or if you have something else as a compensation for that, but that is more difficult.*

For the battles in research, Hercules needs ammunition and he will do anything to strengthen his arms. Even though Hercules is enclosed in a 'physics bubble', his playground is never confined to the local institute. He will always compare himself with well-known international colleagues and look a bit down on people who do not aim high internationally. For some physicists it is comparable to being an elite sportsman.

> P201, F: *[B]eing involved in science is like being involved in sport. You have to train all the time. (...)*
> Interviewer: *And it is important to go abroad as part of this training?*
> P201, F: *It is important to go abroad as part of this training, because otherwise, when you stay here (...). Let's say, I know that, in [my country], I'm the best at what I do. Well, what does this knowledge give me? (...) Like [this famous local sports woman who has won local] championships for, I don't know, 15 or 16 times. Well, everybody says, "good girl!" But I doubt that we would be very happy. But when [she] becomes a world champion or an Olympic champion, then we go: "Ohh!" She also showed that she was strong compared to others. And it's the exact same thing in science as well. (...) If you stay here, you'll start to deteriorate little by little. Because people are lazy. It is very difficult to push oneself.*

Hercules will also have a tendency to put the 'stupidity' and weakness of the other physicists on display in order to promote himself, while being careful of disguising his own weaknesses. On way it to ask for

clarification of vague issues in a lecture even though he knows the answer, but never when he does not know the answer beforehand.

> P24, F: *Well, people have laughed at me mockingly if I have said something stupid.*

> P35, F: *[T]he older people, they would not dream of talking to their students. And I was told that if you asked your professors anything they would give you a low grade at the exam because they would think you were stupid. So you should just ask the assistants of the course. That was a good piece of advice (...).*

> P175, F: *There's the need to prove that one is smarter. Oh, it's really funny, when, for instance, there's some kind of a seminar, well, when somebody gives a presentation, then there are some people – a couple of people who – it's very strange – they ask questions to which they already know the answers just to check whether the presenters know these answers as well and to show that they're smart.*

In a Hercules culture, it is thus not so much a matter of asking questions as how and why you ask questions. If it is because you really want to know or learn, you might be ridiculed as stupid. If it is a subtle way of attacking competitors, it can strengthen your position.

In this sense, Hercules can be very manipulative, and that characteristic enables him to navigate well in hidden competition which may at times border on harassment, but always in subtle ways.

> P33, F: *No. it was about – OK when you are trying to qualify for a permanent position you have to go through an associate professor committee and the female candidate was at her associate professor presentation where a panel of male panel members was supposed to check if she was good enough to lecture. If you aren't good enough at teaching you cannot get the position. And all 4 who were called in had to do this and in that regard, she felt harassed by one of the male participants because he touched her in an embarrassing situation, for*

her an embarrassing situation. It is really a banal situation where the technical equipment fails, the PowerPoint presentation fails, something goes wrong and he is one of our technical wonders. He gets up to help her. That's his version. She feels he gets up to harass her and I think there is general agreement that he put his arm around her. That was the nanosecond in her career where she could have gotten that position and there is only that one position and she was qualified and she didn't get it. She did badly and she feels she did badly because she lost her concentration and he feels she was hysterical.

4.2.4 Power relations

Though a Hercules to some extent must accept that the tasks and the competition parameters are given 'from above' he is also always prepared to question them as he is basically an anti-authoritarian. To be given tasks from colleagues who are formally above you in the academic hierarchy, does not make a Hercules obey – just as he is always ready to mock the parameters put up by people from 'outside' physics research.

P23, M: *A lot of people speak about 'times quoted' as a meter for how good a scientist you are. [My colleague] actually did a survey and found out that the most quoted person from here is a laboratory technician, so from that perspective he should be the best researcher here [laughs].*

Hercules' passion for, and ambitions in, physics work stems from the conviction that his discipline and research is the most important of all. Even within physics, he will always believe his work place is the most interesting and most important. Consequently, all other professions and other (sub) disciplines in academia (and to some extent within physics) are perceived as less interesting and essential, and therefore looked down upon by Hercules. P20 (M) mentions that within the disciplines

of science, physics is the discipline that gets closest to fundamental matters, whereas maths e.g. has no substance at all.

> P9, M: *I dropped material physics and became a pure physicist. Those were the things that I thought was most interesting at the university.*

> P3, F: *There has been – and still is – this idea among a group of physicist that the more abstract the more refined. The way physics is taught at university – and I don't think I could see this myself until I got to [the new university I am at now] because here results are only of value if they have a practical implementation elsewhere, they focus a lot more on utility in class as well as in scientific research – and looking back at my education, the theoretical work was most prestigious because it was hardest to understand. I am not sure everybody agreed but that was the tendency. This physicist image has influenced the way physics was taught in high school for a long time. A 'clean' experiment ridded of anything that had to do with the real world was the highest attainable. And that puts an immense distance between the pupil and the physics they needed to learn. That has changed. But a lot of the former values still remain (...). Not that I have anything against elementary particle physics, but I am just trying to pass on an image. [My field] is not that abstract and it is a fairly new field and very cross-disciplinary. The centre of action is very often in a combination of scientific disciplines like chemistry, biology and physics and other natural sciences. (...) [And that is a positive development because] it makes sense to value concreteness, to have other quality criteria.*

As already noted, Hercules has to learn to read the game in a murky-watered non-hierarchical culture, and he must know of all the implicit ways of getting to a powerful position – and here it is important to be friends with powerful people.

> F, DK: *Well, it's not a good idea to have a bad relationship with the most important person. You have to be friendly with the important people.*
> (Hasse, Sinding and Trentemøller 2008b, 78)

But the powerful people in a Hercules culture are not so easy to identify. There is not much of a formal hierarchy and the 'right people' may not be those with the most administrative formal power. Even being a professor may not give you power as it is your scientific acknowledgements that grants power.

> P25, M: *I think there is a lot of hierarchy. The hierarchy is very much about hot shot researchers, about becoming a hot shot researcher. And it is about talented people and not so talented people. If you are exceptionally talented you are high up in the hierarchy, and if you are talented in terms of research politics you are high up in the hierarchy. I do not think it has a lot to do with having a certain title, professor or something else. That was not my perception of it. It was people who were good at attracting funds, who were good at attracting students; they were high up in the hierarchy and had a lot to say. And people who were very ambitious, or people who were very demanding, they typically got a lot of power.*

In this hierarchy, a Hercules hates to be given tasks by others as this particular physicist who defines it as "definitely negative" (P13, F) when:

> P13, F: *Some people decide from the outside what is important to do research on, and what is important in five years. We think that maybe we should be the ones to decide that ourselves.*

Hercules has problems acknowledging to those who are formally his superiors that he can make mistakes. Yet, when it happens, he is clever enough to (reluctantly) admit his faults. He will always be willing to risk his own reputation, but not stick his neck out for others. Therefore, he is quick to pull out of assignments given by others if he can see they

might lead to failure. If for example a professor gives a young Hercules an assignment, he will not stay and try to solve the task, if he does not believe in the project. He will, contrary to the other two ideal type researchers, pull out immediately. The physicist (P5, M) explains that some Ph.D. students get into trouble because they had been given hopeless projects by their supervisors. They are not able to comprehend their situation, but if they had been clever enough, they would have pulled away and refused to do the task.

> P5, M: *Yes, they would have been able to outsource the project at an earlier stage and realise that it was impossible to go through with it. If you are not that good, it may be hard to determine whether it is you who is incapable of doing the right things with the project or whether it is simply the project that is useless.*
> Interviewer: *So you have to be able to stand up for yourself, to make it clear that it is not you but the project that is unworkable and demand more time, funds etc?*
> P5, M: *Yes.*

4.2.5 Gender

In a Hercules culture, all kinds of people are seemingly welcome in the activity, as long as they perform in a Herculean manner.

> P3, F: *In fact, that is one of the really positive things about physics, that there is room for people with very different personalities, as long as they can perform.*

But the very competitive environment also makes Hercules want to use all means to beat his competitors. This means Hercules use nepotism when it is hidden, but reacts strongly to any advantages given openly to a defined group of physicists – for example women. If someone who is seen as part of a group openly receives special treatment because they belong to this group, Hercules will react against it. He will find it acceptable to mock these people as less worthy physicists. This also goes for example for women who get a position because of quotas and

other types of affirmative actions favouring specific groups of physicists. He will not react negatively against someone who received special treatment through individual contacts. Paradoxically, physicists who get positions through affirmative action can be labelled 'not qualified' while Hercules types who obtain positions through contacts are accepted as qualified – possibly, because it is done with subtlety or tacitly.[27]

> P9, M: *[I]t is really annoying to the girls who really are competent. Because there are a lot of girls who really are very good. And it is annoying to them that everyone within my field thinks "that girl that was employed, I wonder whether she was employed because she is a woman?" And that is annoying to the girl who- One of the most proficient physicists in my field is actually a woman in the USA who is really good. And she has definitely not been employed on account of her sex at all. And it is annoying to the ones who are proficient.*

Some of the above statements, which we have used to define the Hercules type, are by women and we find many examples of women who are Hercules type physicists. So, as already mentioned, being a Hercules is not exclusively a male culture. Even so, we have typically referred to Hercules as a man, because we find more men, who deliver material to the cluster on Hercules. Even in context where women are accepted, the mocking and downgrading atmosphere in the Hercules culture can still pick on women as an easy target.

> P7, F: *[Sigh] I still think that people in the world of physics deal better with the way I look than other people do. I am hardly ever met with questions about the way I dress or why I have a piercing here or there. Somehow, people more or less ignore the way I look, which I like. So to a certain extent I think it has lived up to my expectations, but we are all humans and there are people here too who may think that you are stupid just because you are a girl, they come that low. So, there is a different kind of categorisation, people*

[27] See for instance cases of networking and career advancement described in *Draw the Line!* (Hasse, Sinding and Trentemøller 2008b, 57-61).

> *who are really condemnatory. Even some of the oldies. (...) I don't think that women leave because of discrimination, but simply because the conditions of life are that bad. They don't want to waste their lives like that. (...) They do their PhD and then they think "I really don't want to do this anymore, now I'll do something different". Sometimes they study something else on the side and some of them have gone on to teaching and that sort of thing. It is rarely because they loose interest in the field itself, I don't think I know of anyone who has done that, but they get fed up with the environment and not being appreciated for their effort and they have perhaps 10 years of post doc here and post doc there to look forward to. I don't think women want to do that. They want a goal to look forward to say: "The next seven years I'll be here and then I can do what I want those seven years". I think that the certainty of knowing where you will be the next seven years means more to women than it does to men.*

As this physicist points out, security in the academic world might mean more to women than to men; but in a Hercules culture, the ideal way to act is not to care about security. Moreover, women, more so than their male colleagues, may tend to think that in competition it is more important to work hard than to engage in forming subtle but strong individual connections etc. In that respect, the importance of forming connections to individuals through networking is a tacit knowledge. However, in a Hercules culture it is not enough to be hard working.

> P196, M: *Now that's the message, they dare not take those steps that would help them cope, it's not possible to cope just by being hardworking, you have to become a target, you have to charge a fierce battle and some do, right, but as a rule, there's the tendency that women don't take such steps.*

There can be a particular problem for women – even for female Hercules types – in a culture dominated by males. As Hercules' life centres on physics research, he must sustain his entire life in this bubble. Consequently, he also finds his sexual life within the physics

bubble**.** As Hercules believes that everything in the physics world is his to be won everything is up for grabs, including other people, women are neither 'protected' by formal hierarchies or a macho culture (where men feel obliged to protect 'their' women). On the contrary, they might be perceived as sexual entities – and up for grabs.

> P32, M: *No, I knew he was fond of girls, but never realized he couldn't control himself, or (...) maybe it was a difficult case. His form is always an attacker. He is very direct and very firm, and everyone gets the same rough treatment.*
> Interviewer: *Women too?*
> P32, M: *Men and women, exactly. (...) I think it's very hard to separate this from sexual harassment. At the same time he is the kind of guy who goes to the parties, getting drunk and dancing with the girls. Exactly where the whole case lies (...) I think it's very intricate. But I'm very sad to hear it that he gets involved in this, because he should be an idol on this project (…).*

4.3 Summing up

In the physicists' activity we can identify a number of cultural models for how one should relate to physics, what kind of identity formation is the ideal, how one should act in competition, what kind of power relations are preferable and how one should view gender in physicists activity. We find physicists in all the UPGEM countries and from all disciplines which contribute to these cultural models.

In the Hercules scientific culture, the cluster of cultural models we identified was a particular relation to physics as a 'physics bubble', where physics is the all-encompassing sole passion in his life, the workplace identity is the 'big ego', competition is connected to a one-to-one fight, and the workplace hierarchy is absent and functions as a number of anti-authoritarian power-games resting on unclear and hidden rules. In this scientific culture it is part of the hidden power-game to use the weakness shown by other people for your own advantage. If gender can be used in this competition it will be.

The scientific culture accentuates certain aspects of the general activity of physicists, which can be found at many different universities workplaces and which can be said to include or exclude members in the activity if they do not meet the expectations of the ideal behaviour.

5.0 Caretakers: The Social Physicists

In addition to Hercules, the empirical data also holds clusters of cultural models, which connect characteristics and qualities praised by physicists forming ideal type physicists that we name Caretakers. The Caretakers take a very different approach to the activity of physics wherefore the cultural models directing their actions generate very different connections.

5.1 Relation to physics

In contrast to Hercules, Caretaker physicists are not individualists but collaborators. A significant characteristic of a Caretakers workplace culture is that the physicists form groups and perceive research work activity as based on joint efforts.

> P58, F: *[W]hen I really work, when I do research, I like to go in the control room of the experiment where people work together where I am together with other people. I have never liked to work alone, I am not the kind of person who works alone, who creates a program, a circuit alone. I always need an exchange with the others, for me this is a team work, and I am really disappointed when there are people from a lot of research fields and someone pretends to say that a work belongs to him, when you did it or some people did it together. In these situations, I am really wounded because according to me when a work is a teamwork one must present it as teamwork.*

> P83, F: *We work together; the ones who make experiments work together, if it is not an article for a review (…) we work in this way: everyone measures, we analyze the measures and we write them all together.*

Therefore, we typically refer to Caretakers in the plural form. Like Hercules, the Caretakers have a strong love for physics and are devoted to physics research. Yet, for Caretakers doing physics is not an aim in itself; unlike Hercules, Caretakers wish to be able to put her research into practice so it should serve an applicable purpose for others.

> P141, M: *I am (...) most proud of this project, a general paper, which is our collaboration paper published in 2003. In it, we announce that this software is now complete and can be used in such and such fields. It is one of these general papers that is published in the leading journal in the field. (...) [A]ll who use our program refer specifically to this paper, and we have thousands of users. It is very well cited. So, I think this is the best (and) I am part of the team, (...) there are 100 names.*
>
> Interviewer: *Did you have fun being a researcher?*
> P40, M: *Absolutely yes (...). [T]he fact that you might think of something and being able to realize it, or trying to put a plan into practice.*

Moreover, for Caretakers the social aspect of physics, interaction with colleagues around the world, constitutes a large part of the fun of doing physics:

> P49, F: *Well basically, you have fun because you ask yourself questions, you answer them, you interact in a way, which can be nice. Also the surroundings are pleasant too; you can travel quite a lot, you can meet people from other cultures, you can interact with people who have a scientific education but in other countries. So it has many pleasant sides.*

The notion of interaction implies a perception of physics as an inseparable part of the social surroundings, for which they find it important to do research work that is useful not just within the activity of physics but also for their family and the surrounding world in general.

> P5, M: *[I]t gave me just exactly that (...) mix of something that has a real applied goal, that can make a difference to mankind and at the same time allows you to study physics, do physics research which was really what was driving me from an intellectual point of view.*

As the quote indicates, Caretakers tend to think that their abilities as physicists can prove equally, if not more, useful in society (e.g. in the world of politics) as in the community of physicists. We find that Caretakers often chose to work with fields in physics, which they believe can make a positive difference in the world. Such fields tend to be research work for better seismographic instruments, better hospital tools such as improved laser beams or research contributions that can help in shedding light on climate changes.

As they are aware of the interaction between their research and society, they, unlike Hercules, care whether their research results can be used in a potentially harmful manner. In such a case, they are even ready to stop their research instead of aiming at new scientific discoveries.

> P75, F: *You could find yourself [facing] a discovery (...) that, if used in a certain way, could make humanity progress, while if used in other ways could certainly be negative. (...)*
> Interviewer: *(...) [W]ould you hesitate because of its potential application?*
> P75, F: *Yes. (...) [I]f I were in the state of having something which could be harmful, on the one hand, and very favourable, on the other, (then) I'd rather (...) stop because you can never be sure that this thing is used just[ly]. (...) I think one must be ready to give up something.*

Characteristic of the Caretakers, they find it important to raise awareness of their work – also outside the realm of physics – and take pride in disseminating knowledge of physics to a wider audience:

> P20, M: *I often give talks to extramural groups, but I also have a recurring engagement at certain debate arrangements in secondary*

schools. People contact me, and if there's room in my schedule, I'll go. The same goes for guided tours given to secondary school classes. They are given talks on our work, and we show them around the place. We actually spend quite a lot of time on dissemination in this place. And I would say that this is one the aspects of my work that I get pretty heavily involved in. I am more focused on dissemination, in that respect, than on teaching.

P166, F: *I do visit the university all the time. About once a month I participate in – it's a hobby of mine – they offer didactics of physics. (...) They have these seminars, which are mainly meant for those who have chosen teacher training as their specialisation, people who are either working on their master's theses, or their minor subject studies, or licentiate theses or doctoral dissertations as the teacher training option.*

Caretakers will express worry if the public does not understand how useful and good physics can be for the development of society or if society does not show interest in physics.

P21, F: *(...) [I]f (...) I said that I was professor in physics people would run away screaming. (...) So I'm absolutely sure that the general image of physicists is really bad (...) we could try to do some outreach repair that drew more attention to the fact that we get fascinating results and that we are interesting and sensible people.*

This worry, combined with a genuine interest in disseminating physics, may lead some Caretakers to either abandon research for teaching or find a way to combine the two.

P44, F: *(...) I liked the idea of teaching and I still do. (..) I like working with children. I like the fact that I can experiment with them. I like this world of young people, this world of youth, their reasoning. I like interacting with them.*

In short, the Caretakers feel the need to have a wider purpose with their work than simply improving physics. Another aspect in the Caretakers relation to work is a healthy balance of the relationship between work and family life, which creates a wholesome life. Therefore a family is a fully integrated element in their professional life. They do not believe that you make better physics by being isolated from the family for which the family is not something to escape from in order to get peace and quiet to do physics. Rather they enjoy integrating work and family and arrange days where the family visits the work place and engage in social gatherings with their colleagues.

> P11, M: *I definitely think that the younger [colleagues] who have younger children do that [i.e. prioritize their family].*
> Interviewer: *Do you ever speak of children and family?*
> P11, M: *Yes of course we do.*

> P6, M: *(...) We know each other's children. We know how they are. (...) When we were younger, we saw each other a lot. Or we saw each other in smaller groups. (...) We had dinners in our homes. And we had the laboratory picnic where everybody participated, young and old, and people brought their children, so we got to know each other. It was really very nice. And we had Christmas lunches with spouses. (...) If everybody has small children, it is fun to arrange a picnic where you do contours in the forest and competitions.*

In a culture where Caretaker values are predominant, even the leaders will prioritize family life and children in relation to work.

> P21, F: *Many in the group have many children and they prioritize the care of their family very high[ly]. I have always picked my children up at four o'clock. Always. For that reason we never schedule meetings late in the day. (...) And if there is a child sick that is never a problem and we help each other take care of classes and what not. I think we have very child friendly politics here.*

A Caretaker group leader does not see pregnancy as an obstacle for doing physics or find parenthood to be a de-selection of physics in spite of the many non-physics related obligations that come with children. For Caretakers, the challenge of combining work and family does not lie in the question of devotion once you become a parent (as it is the case in the Hercules culture) but rather a question of making it work.

> P70, F: *[T]hose who have children it's a problem, because either it's a nursery or changing a babysitter anyway, me, until recently, as I was breast feeding Luigi at the afternoon, I was working for 2 hours, then I'd go home to feed him and then I'd come back to work.*
> Interviewer: *Do you live nearby?*
> P70, F: *No, I don't live close to the institute, but he would stay with his babysitter at my mother's who lives a bit closer to here; anyway, you get organized somehow.*
>
> F, EST: *Well, my mother helped in looking after my child. When I was finishing my Master's studies.*
> (Velbaum, Lõhkivi and Tina 2008, 195).

The Caretakers acknowledge that they are dependent on the other members of the family and are grateful for what they do for them, be it looking after the children or providing financial means for physics education. Thus in relation to the family and the integration of the two spheres, we also see the notion of a team effort in the Caretakers.

It is important for Caretakers that family members have an understanding of their work and support their efforts in physics. It is also important for them that this support and understanding is reciprocal. Caretakers take, for instance, the family and the career of their spouses into consideration when planning e.g. new job opportunities or research stays abroad. If possible, the Caretaker physicists will prefer to bring the family on fieldwork to going on their own.

> Interviewer: *[I]f you got the chance to go to the [to a foreign country] for a year or some other place, would you do that with no regard for your family?*

P1, M: *No, I would never do that. If I went to [to a foreign country] I would bring my family. And we have been in [to a foreign country] for six months in 2001 for two months and in 2003, the entire family. And that was a great trip. Yes really.*
Interviewer: *Was that in the context of your work?*
P1, M: *Yes.*

They will not work long hours or go abroad if it means neglecting the family responsibility.

P39, M: *I live with my girlfriend, so how do I manage? Let's say that, well, I am fine, I mean I work 8–10 hours, depends on the situation, sometimes even more, then my work has its ups and downs, so sometimes we work 12 hours a day, so if you've got to complete a project or there is a problem, or sometimes you work normal hours, so once you finish your work you get back to your hobbies and free time.*

Sometimes the Caretakers can also feel so tied into the family network and so obliged to be responsible that it puts them in a dilemma. This may be if Caretakers are offered a good opportunity to work in a foreign country or other options that will take away time from the family. As Caretakers accept and acknowledge that the family network is a necessary condition for their career, they may decide to turn the position down.

Interviewer: *Would you sacrifice an important work assignment to be with your family so you didn't let them down? What comes first in that situation?*
P21, F: *It's a dilemma. If I asked my family they would probably say that I would try to everything. I put a lot into my schedule and that sometimes affects both work and family. I would absolutely sacrifice work for family.*

The Caretakers also value spare time to be used at other things than physics – not simply because it is fun, but because a wholesome life

generates better physicists. Consequently, ideas and interests outside physics are not only accepted but also welcomed because they are perceived as creative contributions to research work.

> P37, M: *This is something I often found in my colleagues in physics and I think it is the best thing about them, because with meticulousness anyone can achieve the best results and [that's] great, but something special must be there as well. I attribute it to imagination, other things don't do it, I mean, when you are capable of dreaming about something that the others don't see, then you have this special thing inside. I think that (X) is an incredible dreamer. He used to play organ in the seventies, he played rock music, so, I mean, playing, managing, all these things, in fact it's strange.*

> Interviewer: *What was the best thing about your colleagues?*
> P29, M: *[That] they had other interests outside physics [laughter]. (...) It was important to me that when we had our coffee break, we talked about rock climbing, sailing, riding mountain bikes and all sorts of other things. That was one of the most important things to me.*

Thus, creativity and play do not only apply to the Hercules, but can also be a feature in Caretakers, yet in the Caretaker context creativity also includes matters outside physics while play within physics will aim at serving an applicable purpose.

> P172, M: *Just for my own enjoyment, from the mid nineties onward I read about it for some years. And I talked about it to the person who's writing his dissertation, and I taught the basics to him. (...) [I]t has proven to be a very fertile research subject. Although it started out as a hobby, it has both supported our accelerator project and opened a whole different branch of research that can be applied to different fields, not necessarily physics. (...) The Physical Society organizes a conference once a year (...). He will give a presentation there. (...) [He] asked me if I wanted my name on it, because it's such a hot topic, raises a lot of opinions. I said: "absolutely". I read it, and it's quite prominent there now.*

As seen in the above, the Caretakers are also willing to share and develop research results with others. Creative new thinking is not to be seen, as only an individual's own thinking but a group effort involving other people.

5.2 Workplace identity

In contrast to both Hercules and Worker Bees, the Caretakers prefer to work in small close-knit groups of collaboration. They believe that if the workplace environment does not build on knowledge-sharing and collaboration, physics will not develop in the best possible manner.

> Interviewer: *Would you describe your job as individual or rather as teamwork?*
> P64, F: *Teamwork, it should be teamwork (…) because the main thing about an experiment is communication, exchange of knowledge. (…) You do a small thing, which will later on help somebody else do something, and then [a third] does a small thing and passes it on to you, so you can complete [your work] in order to do other kinds of things. [B]ut it's not always like this, because very often there is a lack of communication between people, partly because they are lazy, and partly because of (…) your desire to share your knowledge or keep it to yourself.*

By organising research as primarily group work, contacts and social relations come to play a more prominent, and in some cases limiting, role in the Caretaker culture compared to the Worker Bee and Hercules culture.

> P37, M: *Yes, [I was] not just seeing what the others were doing and competing with them, but trying to have [my] goals entering into a wider context (…). [There] was such a big project that I constantly tried to be in contact with [a researcher] – on a daily basis – when he was doing something for this bigger project. Even [though] he was interested in my thesis, I tried my best to get into this bigger context, and it was definitely fruitful.*

One of the reasons for this orientation toward the social context is that in a Caretaker culture, everybody can contribute to the decision making processes – as long as it fits the group dynamic. Another characteristic of the Caretakers is, as mentioned above, the acknowledgement of the team effort behind new findings and inventions in science. While Hercules promotes his own efforts and skills as fundamental in new achievements, Caretakers never connect groundbreaking findings in physics with the work of one genius, but emphasize the team effort:

> P60, F: *[T]here's always a team behind a genius. (...) Good teamwork always brings the best results, but of course, not everyone is lucky enough to find a good group to work with. Sometimes when there are very competitive people, it is difficult to form a group.*

Forming close-knit groups puts a demand on the Caretaker physicists to bond with their colleagues and contribute socially to the group. Social bonding is recognized as a way to make groups function better.

> P205, M: *Well, (...) I worked in another building, but when I came back, (...) I was still a full fledged member of the [group] in my laboratory, (...) I was still the boss – not the boss, but (...) a full fledged member of the family.*

> P129, M: *[W]e are all more like a family (...) because there are meetings outside, you know – some during the carnival, bonfires, conferences. (...) [I]n this way people get to know and integrate, and the atmosphere is very good.*

Being part of the professional family is not only a way to ensure a place in the group, it is an aspect of the wholesome life to engage socially with colleagues and "feel at home" (P61, F) and (P18, F) at work.

In the Caretaker culture, a core element in collaboration is to provide assistance. Helping each other is seen as one of the strengths of being in a group.

> P131, F: *[That] person (a colleague) helped me, and she (...) has just made a big scientific career (...) [and] she was always kind to people, which do not always go together (...). She just very willingly helps people, and she also just develops (scientifically). (...) [T]hese are such features which are very important; that you are a wise person but at the same time kind to other people.*

But Caretakers also see helping each other in the group and willingness to co-operate as a means to making the group work more efficiently.

> P64, F: *[I]f you discover something (...) like an error in a programme you inform the others. If you had a small break through and it took you a lot of time and you realize that another person, more or less important than you, needs this part you think: "Oh dear, [because] I worked so hard and we are in the same group, we work together, I am going to pass it on, so (...) they don't need to start from the beginning (...)". That's what communication is for. Usually you cannot run experiments on your own and (...) the amount of work is so huge and there are so many things that need to be kept under control that one person simply can't do it alone.*

> P42, M: *[W]ell, when you get to a place where someone does not work because s/he is offended because you won the competitive examination instead of him/her. Another one does not come to work because s/he is a trade unionist. A third keeps his mind as a secret the way in which you (...) turn machines on and off (...). A forth does not listen to what you say, for example you [say]: "if you do not want to loose the whole day by doing this (...), do it in this way", and then this person does not want to do [it] because you were the one who suggested it. Well, this is perverse; such a situation is perverse!*

Moreover, we find that in Caretaker groups, providing help is not determined by your position in the group: Professors help the less experienced physicists, but less influential group members can also help the group leader:

P38, F: *There's a boss who's half crazy, but, in fact I give psychological assistance, I should have a plus ultra. (...) I help him, this mad man! [laughs].*

Owing to the wider context, Caretakers pay a lot of attention to helping each other at the workplace and thereby sustain each other's as well as their own careers. In addition to the social aspect of Caretaker groups, collaboration based on knowledge-sharing also puts a demand on Caretaker physicists to show initiative and contribute to the work on their own accord.

Interviewer: *Do you think of your job as an individual task or teamwork?*
P55, F: *Absolutely teamwork, being able to work together is crucial, yet, the individual contribution is highly important, (...) even when you work together, the individual efforts are precious, there is a mutual enrichment that is only possible through single contributions.*

Nonetheless, Caretakers do not fear being categorized as either clever or stupid (or included in or excluded from the group) by their superiors.

P44, F: *[A]nd then I can think of another person who (...) really helped me several times. (...) [B]ut the person who really supervised me more than anybody else was the one from the CNR. (...) [W]hen you work with other people, especially when you discuss things with people that make you feel at your ease, then you can freely say what you want, whatever comes to your mind without thinking that you might be wrong and so on. Then you might get some backing from the other person and be proved to be right, or your ideas, just like the ideas of the other person, are taken into consideration. (...) I definitely need this collaboration.*

An integral part of helping each other is the courage to show weakness and insecurity so these can be addressed and turned to strengths.

P38, F: *What I am trying to say is that in a wrong context we risk loosing such powerful minds as Einstein, as we should not forget that Einstein was not good at math at school, he was actually strongly advised against scientific studies!*

In contrast to the Hercules culture, it is possible for Caretakers to ask 'stupid' questions without being ridiculed by the others. In fact, in this culture asking questions is respected and appreciated, as it is a way to better understand matters in physics.

P85, F: *[T]here is much competition, especially among research groups conducting experiments, because they try to get more funds and places. However, people are friendly with each other (…). Indeed, when [we] have lunch together, [we] talk about everyday life and jokes. Therefore, it is a peaceful relationship. You also discuss about your work with your colleagues, pointing out any possible mistakes made.*

As the above quotes illustrate, Caretakers demonstrate almost the opposite conduct of Hercules when he is out to put the stupidity of others on display, by for example, humiliating them at lecturers. Unlike Hercules and Worker Bees, Caretakers praise good colleagues and are pleased when group members have success – this may come more naturally to Caretakers as the success of a group member will benefit the entire group. Naturally, close collaborations can be challenging and require respect as well as willingness to compromise when group members have diverging opinions to new results. In such cases, preserving group harmony overrules the fight for ones right to go it alone.

Interviewer: *You exchange your views and opinions?*
P85, F: *Yes, it may happen [we] have an argument or a quarrel, but then –.*
Interviewer: *You don't bear a grudge?*
P85, F: *Exactly.*

P46, M: *[I]t is not about doing the best thing, it is about making people with different opinions come to an agreement, which is complicated.*

> *(…) [P]eople can have different point of views on the same research problem and then there are some selfish people who want to impose their point of view, and in a research group, it is difficult to cope with all these different aspects. (…) So you also need to be able to walk on a knife edge, it is not simple to deal with this kind of thing. (…) [I]t is about respect for other people for their ideas, that's always the right thing to do, and then how to get to a compromise – if there is a possible compromise, whether someone has stronger reason than you have or not.*

Hercules would never compromise but put up a fight while Worker Bees would rarely, if ever, find themselves in situations where they would have to compromise as they tend to leave the decision making to the management. The nature of the battle described by P46 above is very different from the battles in the Hercules culture, and Caretakers generally dissociate themselves from the research custom (practiced by Hercules types) involving the theft of research results from colleagues etc. (see also Hasse, Sinding and Trentemøller 2008b, 77–81).

> P58, F: *Anyway, one is a bit ambitious and one would like to go far and sometimes someone tends to rob you an idea or your work; this is a dishonest way of working.*

> P61, F: *I really admire my professor who helped on my thesis because he was one of those people (who), apart from being well prepared scientifically (…), [conveys] the idea of completeness, of real wisdom. And (…) he's also such a nice person; that is all his millions of years of teaching and work for university haven't gone to his head. He's the sort of person you'd like to become (…) one of those who would never cheat you, an intelligent person who would never take advantage of you.*

Once a Caretaker group is formed, the members are prepared to make it work, and Caretaker leaders show a high degree of flexibility in terms of the structure of the work. The individual groups typically find ways of working that suits the group members, but the notion that long

working hours is the only way to show devotion is not part of the ideology of the Caretaker culture.

> P29, M: *In relation to physics, the best thing about them was that they were really, really passionate about their subject. Many of them had brought their wives and children here to be able to be a part of this group, in order to create a career in physics. (…) I worked with a guy (…) who had come here from Sweden and later went to the northern part of Norway with his family. And I worked with a guy from Switzerland, and he had started a family with a (…) woman here, but he also travelled on to another place. (…) If you were talented enough to join this group, then the boss would also be very willing to show a high degree of flexibility as he did with me. He was very concerned with keeping us there. So for example, some of the PhD students worked part time instead of taking maternity leave. In that way, they could still come to work everyday and then leave at noon or something like that.*

Paradoxically, the high flexibility within the group is not matched with flexibility in switching from one group to another. Due to the inter-dependency in the united group it can be very difficult to move from one group to another, and Caretakers are to some extent tied to their group.

> P62, M: *[I]f the research group (…), [a] small group of people, (…) if it remains united, it has the possibility to have a future in the long term. I mean, it can realise other activities and other initiatives always together. [I]f you split up, eventually you end up in other groups and you become the fifth wheel perhaps of a bigger group. (…) [I]f you stay though, maybe it's small but cohesive, you've got a certain visibility, a certain structure, that enables you to do the things we're all doing. Here in our group they're smart, they're smart enough to understand this (…).*

> P71, F: *[W]hen you want to go ahead with a particular research line, you (…) need to (…) be related to a group (…) that's dragging you, someone who is already moving it forward and is therefore*

> *sustained, not economically, but in terms of people who work on it. [T]hat's what I do, because as someone who comes from [x university], I obviously remained in touch with the people I used to work [with], and so we keep on working together on some things.*

Hercules benefits from his independency in the way that he can easily go where his scientific interest takes him. Caretakers, however, will have difficulties pursuing new scientific interests if the group does not accept it[0]. To go it alone is impeded by the extensive planning of the work in Caretaker group work; unlike Hercules and Worker Bees, Caretakers will discuss and plan future steps carefully before making a decision and putting them into action.

> F, DK: *(...) So we do cooperate, and people are good, from the beginning when you plan these projects, at thinking of who is responsible for what. We all work together on things [like] who is the head, who is the main author of the articles that are written in what areas, so those things are clear from the beginning. (...).*
> (Hasse, Sinding and Trentemøller 2008b, 77)

Moreover, the fact that Caretakers work their way up within their groups and as a reward are taken under the wing of the leader adds to the impediment of mobility between the research groups. Earning your spot in the group can be a long and slow process. Firstly, because the other group members must feel certain that you are right for the group:

> P25, M: *[My colleagues] were all nice people, who were really enthusiastic about what they were doing. They were all willing to most of them were willing – to help. A very collegiate atmosphere (...). I think the worst thing about my colleagues was probably that, because I came from the outside, for the first long period of time I felt like I was perceived as an outsider who constantly had to prove that it was not a mistake I was there. They were always insecure about my reasons to be there, and I thought that was annoying in the beginning. I felt like it took a long time before I was accepted as part of the place, (...) that element was always there for about two years.*

Interviewer: *You had to fight for your own position?*
P25, M: *I do not know if I had to fight for it, but I was often reminded that I did not originally come from that place but came from the outside.*

Secondly, because the power structure of most Caretaker groups entails that the less experienced group members (typically Ph.D. students) must work their way up and younger members of the group must expect to be subjugated by elder an more powerful members.

P38, F: *He [the professor] is not someone who exploits students, but he has this approach, a bit easy-going (...) there are things or some jobs that are really stupid, that no one does. (...) [T]he laboratory, I main (...) well, we maintained it, I mean if the big tank with frogs had to be cleaned, where the experiments were [done], we [the students] would do it (...) even if a computer had to be cleaned! And arranging dissertations, I mean these things, clearly (...) I expected him to let me do things [laughs] (...). [I]n the end (...) he did let me do a very small thing, but, it was very marginal.*
Interviewer: *And did he have other collaborators?*
P38, F: *Yes, and that's the point. (...) [H]e had his students, and they needed help as well. I mean (...) when you find yourself in a situation where there are a few PhD students, and no money for research, I mean it's not that the professor's behaviour is mean.*

As the above quote indicates, the new members accept this hierarchical division of labour, even though it may border on exploitation. They accept it because Caretakers know it is part of the reciprocal relation between Caretakers in a group. To make an analogy to the competitive nature of the Hercules culture; this is the Caretaker way of proving one's worth.

Another way of earning one's way into a group is to show interest in the given project and to contribute with extra work to and for the group.

P37, M: *I don't know if I was the best, but I was very enthusiastic, and so when the moment to start this project arrived, I proposed myself, I*

showed I was very interested to work on it, and I think they liked it (...). I was really surprised that I managed to get in, but I have to say that (...) I was not just doing my things, I tried to do more.

In some respects, the type of networking P37 describes resembles the type of networking we find in the Herculean culture; however, the difference lies in the openness and thus general awareness about the rules of the game.

5.3 Competition

In the Caretakers' culture, physicists compete on different levels and on different matters. Firstly, Caretakers distinguish between in-group competition (typically referred to as hidden and destructive and competition between groups (typically referred to as open and good) (see e.g. Ajello, Belardi and Calafiore 2008, 305). Secondly, it is important to note that Caretakers compete on scientific merits as well as personality and social compatibility with the given group.

Like Hercules, Caretakers are aware that physics is a competitive discipline, and they generally agree that open competition between groups can spur creativity and increase efficiency.

P37, M: *[T]he desire to be better than the others makes you grow, but you might get to a point of paroxysm where in order to be better you elbow your way ahead, and that's absurd. (...) But a little bit of competition should be there, if there isn't it takes you nowhere.*

Competition between groups is perceived as leading to increased focus on the goal, i.e. to come first with or be the first group to publish, new results:

P51, F: *The competition motivates creativity, that's for sure, but then you should see the way people react to it, I mean there are some people who give in and therefore they give less than they could if they were left in peace so to say.*

However, the latter quotation also illustrates the prototypical Caretaker attitude to competition: Open competition between groups is accepted, whereas hidden in-group competition is strongly opposed, because one-to-one competition among close colleagues is perceived to be destructive. This might have the effect that new creative solutions are not suggested or that group members are not challenging in efficient ways of working if they fear it will upset the group. Caretaker physicists find that competitive actions within the group (i.e. exploiting an opponent's weaknesses for your own benefit) go against the notion of sharing and helping. Consequently, competition is likely to corrupt collaboration and may even hinder development in physics.

> P38, F: *[I]t's said that competition brings out the best qualities of every single individual due to a simple survival instinct, therefore (…) those who are responsible for a group tend to create a spirit of a 'healthy' competition among the employees. I don't believe there is such thing as a 'healthy' competition, because human soul is corrupt, so to say, and instinctively, out of fear and survival spirit, it tends to surpass the others.*

Though Caretakers try to dissociate themselves from Herculean competition, they have often come across it (because it is such an integral element of physics *as* culture) either in other groups or within their own group, which they find strenuous to collegial relationships.

> Interviewer: *Do you think that this competitiveness has influenced your career too?*
> P60, F: *Not really, because I always try to avoid those situations (…). I'm ambitious in a way that I want people to appreciate what I do, this is important for me, but I would never hurt anyone. (…) [F]or me the most important thing is to establish a good relationship with the people I work with, everything else comes after, this is why I could not deceive the people I work with. And I am sure that at the same time they wouldn't do that to me. (…) I've always avoided those who were in the spotlight, who are also the most ambitious, the famous ones.*

Being a social climber (i.e. to promote oneself at the expense of the group) is unacceptable because it undermines co-operation. Instead, loyalty to the group must go before personal promotion.

> P108, F: *I really detest (...) when people don't call things what they really are. (...) I find it very disturbing, but I do not know many people like that, or I try not to know them. I value loyalty a lot. What I mean is that groups, which cooperate with one another and work on an important project together (...) we want to publish the results first or do it the best out of anyone in the world, and that's where loyalty is very useful.*

However, loyalty to the group may also cause dilemmas for individual physicists if, one works faster or sees things differently than the group:

> P14, F: *Well, I've been in situations where you have to fight for some things, and then there are some colleagues who I have a closer relationship with and who I trust. But (...) in some situations I felt like I had gotten in a tight corner between being loyal to them and then still do well in the [overall] game. Then I prioritize the people I trust, and the people who play a harder game I also play hard with them.*

But, if someone begins to compete with their group members they will be excluded from the group.

> P83, F: *Look, I am happy here, well, there were some unpleasant people, but fortunately, they are no longer member of this group.*
> Interviewer: *Was there a power struggle, did anyone want to predominate?*
> P83, F*: There are people like [that], we must be honest and admit it (...). [T]he reason was not that they were physicists or that they were men, they were terrible social climbers, they could have killed to obtain something.*

In a Caretaker culture, the physicists do not denigrate each other in competition in the group. As P38 explains below, if the survivor instinct remains uncontrolled or maybe even encouraged on the pretext of healthy competition, "*then it all comes to the rule of the strongest, which is only harmful, because the strongest does not necessarily mean the most suitable for a particular task, while it could just be the most cunning in this particular context*" (P38, F).

In other words, here we see a conflict between the strongest and the most suitable physicist.

From a Caretaker's perspective, being the strongest or the most resilient fighter does not qualify you as the most suitable group member. In fact, in this cultural context, it can be more important to find a socially suitable person than the person with the highest merits, because social compatibility is a perquisite for groups that rely on loyalty, mutual assistance and friendship. This type of distinction between the scientifically most qualified and the most suitable physicists does not exist in a Hercules context.

Caretakers also differ from both Hercules and Worker Bee physicists by acknowledging that career advancements largely exist through a system which to some extent is set up by the more central physicists (professors, group leaders etc.), but which requires the acceptance and co-operation of the wider context in order to work.

> P55, F: *[Y]ou are hired for a particular position and then there are career promotions through public examinations [i.e. competitive examinations[28]], which I don't think guarantee that the best prevail, (...) it's not about merit nowadays, it's about collateral compliance with the management.*

> P61, F: *[Y]ou have to find yourself in the right place at the right time (...), you have to meet the right people (...), perhaps you find yourself in situations in which (...) you might not be the best person*

[28] In this context, public examinations and competitive examinations are the equivalent of *concours*, which must be won in order to earn positions etc. See also Ajello, Belardi and Calafiore (2008, 304).

> *[or] be in an unfavourable position, and so it depends on a lot of things, but also on how (...) you work [and] what you can do, even things that go beyond what you want.*

Caretakers are generally aware that to some degree the reward system involves parallel mechanisms in which the public system resembles a charade, because the outcome of competitive examinations and similar scientific evaluations depend on contacts and compliance at a tacit level, i.e. it is "organized without transparency and meritocracy" (Ajello, Belardi and Calafiore 2008, 304).

> P82, F: *[A]t present (...), there are no competitive examination. If, if there were – .*
> Interviewer: *A parallel mechanism would start?*
> P82, F: *Exactly, the entire mechanism (...) which (...) do not depend in any way on the curriculum of the physicist. (...)*
> Interviewer: *So you could carry out a promotion activity (...). How does it work?*
> P82, F: *Yes, yes indeed. Well for example, when you see these people [the professors] you must say: "Yes doctor, I do it right away". Unfortunately, I can't do it.*

For the Caretakers, however, the dual system of selection mechanisms is not tacit knowledge.

> M: *We can't accept a system which is said to be democratic because the examination is open to everyone, and everyone has the same opportunities, assessments, titles and exams, but actually it's already decided who will win it. (...) I noticed this during the two competitive examinations I took part in. In my second examination the winner was a person who "had to" win. It had been decided that this person would be the winner for political reasons, although he didn't do very well in the exam. Therefore this is the first thing to change, in my opinion.*
> (Ajello, Belardi and Calafiore 2008, 304)

Possibly for that reason, we find few 'surprised' physicists in the Caretaker groups when allocation of positions does not go as expected. A so-called "victim" (ibid., 304) knows that they are next in line. Though they understand and accept the way the system works, it does not mean Caretakers approve of it.

> P84, M: *If you are taken on but you aren't good, the person appointing you is responsible for that choice and therefore his/her career may be damaged too. For this reason, it would be better only to take on people with skills and competence and to have a written statement of responsibility from the person taking them on.*

However, due to the dependency on the group, Caretakers seem obliged to comply with the group plans "*no matter how rotten the system is, you try to stay"* (P61, F). Because of the dual system, transparent power systems become important, as they can threaten the group harmony if members are kept unaware of decisions and disagree with the outcome of the decisions, when they find out. To some extent, the Caretakers share some characteristics with the Worker Bee culture regarding the role of group leaders. Caretakers believe the group leader should play a prominent role in managing the group rather than letting assignments of tasks, responsibility and level of influence be up to the individual's creative ideas or uncontrolled competition among the employees.

> P38, F: *I believe that a great manager (...) is one who can tell the qualities and the limitations (...) of every single employee under his or her supervision, in order to be able to distribute responsibilities in the best suitable way, to make the most of their talents inciting them at best. This [will] bring out the best abilities of the employees, where each of them would have a task without having to compete with the others, in an atmosphere of collaboration, sense of belonging to a group and with the idea of the common good. (...) I think the establishment of a shared idea of the common good is crucial!*

The difference from the Worker Bee culture is that in the Caretaker culture the group leader's first job is to act for the common good for the group.

5.4 Power relations

Leadership is not considered a platform for absolute power (as it is in the Worker Bee culture) but a job, which can be managed more or less competently. The Caretaker physicists' definition of good management skills indicates that qualities other than scientific skills are valued highly. The general attitude is that a good leader must be a *"very good person, maybe not the best between the physicists but a very good one to man, since in our work (...) it is very important to manage things well. (...) [M]aybe he/she is not the best one, but anyway he/she is good and at the same time he/she is good at managing, at finding funds, at using them in the best way, at making projects, at thinking and making projects (...)"* (P74, F).

As in the case of finding the most suitable person for the group, Caretakers also stress the human qualities of the leaders as equally (and in some cases more) important as their scientific merits.

> P62, M: *[S]he (A female professor) has been important because she could link different qualities, so she created a different kind of relationship, (...) [and] she plays the role of professor very well because she's a very correct person (...). [She has] the capability to laugh a little bit about things, to smile about the thing one has done, that is do something but recognise its limits.*

The Caretakers particularly stress loyalty, interest and care for colleagues as important qualities:

> Interviewer: *How would you describe the hierarchy or leadership at your workplace.*
> P148, F: *Well, it is pretty low at our department. You can always go to your boss if you have something to talk about. (...)[X] who was our boss (...) is an absolutely brilliant character. She always has*

> *time, even if you have a completely stupid thing, she always finds the time from somewhere. And [X] has continued it [that style]. Usually, when you talk with bosses, it's about money, but here you can go and talk about anything, like a problem (...).*

However, the concern goes both ways:

> P63, M: *My boss, for instance, takes too many responsibilities on his shoulders. He's such a lively person and loves his job so much that whenever he hears about something to do, he's ready to give his support. (...) He's rumoured to be a person who wants to get on in his job, a social climber, but if you know him, you realize he's not like that (...) he's naïve and loves science.*

Compared to the two other ideal type cultures, it is characteristic for the Caretakers that they never feel uncertain of, or fear, their group leader or other powerful Caretaker physicists. One of the reasons the human qualities of the group leader is important is that in Caretaker groups, leaders are expected to use their powers and recognition for the benefit of the group and not primarily to gain personal advantages.

> P120, F: *[W]hen the former boss retired, the [new] boss of the Observatory was a woman, professor [X] – and she really did put up a fight for us to be noticed around the world.*

Even though Caretakers are basically group-oriented they can accept leadership if it is perceived as fair and transparent.

> P129, M: *[I]t's possible to talk to our manager and you don't feel (...) that it's our boss – you come, tell him, complain to him and he says that he can't do something and explains. (...) If he explains, that means that he understands – it's not [like] a general's decision. He must explain to us why he doesn't want to agree on something.*

Due to the nature of the close-knit groups in the Caretaker culture, group leaders have absolutely no right to bully their colleagues into

following their decisions. The high sense of legitimate leadership and co-management may leave the impression of a flat power structure:

> Interviewer: *Okay. How would you describe the hierarchy, or leadership, in your workplace?*
> P142, M: *Not a lot of hierarchy. Nothing like looking up to people and sidling about with your hat in your hand. It's very friendly and, how to put it, a familiar atmosphere.*

> P21, F: *I agree, that we have a very flat structure. And a lot of the responsibility is laid out to the employees. There isn't many levels in it, it's not like we create a comprehensive hierarchical management.*

However, to define the Caretaker culture as characteristic of a truly flat power structure would be misleading, as the division of work in many of these groups indicates that the less powerful physicists must work their way up through the internal group hierarchy and hope it secures them a seat in the queue.

> P39, M: *[T]here is a collaboration (which is) civil, human, I mean where there's a problem we deal with it (...) without being competitive or, what's it called, envious.*
> Interviewer: *[A]nd what would be the worst thing about your colleagues?*
> P39, M: *[M]ay be that they are [so] few (...) so there are many things that I end up having to do, like cleaning containers. So there, no, I don't mind.*

> P42, M: *[W]hen I arrived here (...), they asked me to become the person responsible for the whole laboratory calculation service. I was not able to do such a work because I did not care about it; I did not want to do it. But, in conclusion I worked hard for two years, I worked alone (...) [and] during the time I got no great help from the management (...) I did everything by myself, I worked like a slave, then when this work ended and I began working with X, who came after me, the work began again. I had already cleaned everything, everything was in order, and he had to begin all over again.*

In addition to working one's way up, it can be crucial to find not just the most powerful but also the right leader or mentor when aiming for positions in the scientific environment:

> P39, M: *[U]nfortunately, in [this country] you've got to choose the right professor to be able to do research. (...) I've discovered that if you chose an associate professor like mine, you don't get scholarships. (...) [I]f I had chosen a full professor (...) I mean you might wait for 4, 5, 6 years but you've got a chance, while if it's an associate professor (you have no chance) [laughs]*.

In order to gain power, a Caretaker physicist must acknowledge the relational ties that permeate this culture. When they reach a top position (and if they possess the right Caretaker qualities), they accept that the reciprocal exchange of favours means that the gained powers must also be used for the benefit of the group, either by fighting for the group or in another way using the system to help loyal physicists.

> F, IT: *I mean I would have preferred to stay there. I tried to do a Ph.D., the problem was, when I graduated Professor xx was about to retire, I mean he was, let's say, about to leave, and so he told me straightforwardly that he had no, let's say, power to, political as well, to obtain a Ph.D. position for me, because unfortunately it was rather a political question (...) He said to me: "Look: try to refer to xx" this other professor, my professor told me: "Even unpaid, you go there once a week anyway, show up, do something!" In the end he made me dust the dissertations.*
> Interviewer: *Are you joking? No. It's true! (laughs) Making coffee (laughs), all things like that.*
> F, IT: *I wasn't one of his human resources, let's say, in quotes, 'I did not graduate with him,' let's say, it was already a favour that he let me be in his lab, you see what I mean? Hoping that one day he would offer me something, you know?*
> (Ajello, Belardi and Calafiore 2008, 285)

In the same way as Caretakers will work to get fellow physicists into the environment, they can also accept that particular members are excluded from (or even harassed out of) the group if they do not comply with the group or do not reinforce the group mentality.

> P42, M: *[T]he problem is this one: To do this job you have to make compromises, (…) sometimes they are political compromises, not in the sense of parliamentary politics but in a (…) broader sense. (…) Well, now (…) it is said that research must be quite free and above all it must be objective, (…) (but) this is not as it is thought by [X] and by other professors (…). (So) at a certain moment one, instead of making these compromises, one changes his/her work.*

In case of disagreements, the fact that many Caretaker groups tend to be small in size, in order to keep it close-knit, can complicate the situation for the inappropriate members:

> P19, F: *Yes there have been coincidences like that [disagreement between the group members], not involving me especially, but I know others have been involved in things like that. That can be difficult because it is a highly close-knit group. And you depend on all the others. (…) [S]ome of [the cases] have been solved along the way, and some of them have been difficult to solve. (…) I do not think [they were cases of] bullying even though people may believe so. I perceive it as being problems in relation to delegating responsibility and who the representative in the outside world is.*

If one does not follow the tacit rules of the Caretakers culture, the hierarchical structure shows itself in the sense that the inclusion process becomes much slower and maybe even impossible.

> P82, F: *If you're not on somebody's case if you follow the rules it is easier of course.*

5.5 Gender

As discussed in by Vainio in *Draw the Line!*, the natural sciences are often defined as "*objective, neutral and genderless; being male or female is considered irrelevant from the point of view of research*" (Traweek op. cit. Vainio 2008, 244) Yet, the empirical data holds a number of examples that women try to downplay their femininity in order to fit into physics *as* culture (ibid., 239-40, Ajello, Belardi and Calafiore 2008, 327, Hasse, Sinding and Trentemøller 2008b, 105). However, femininity seems to carry different meaning in the Caretaker culture than in the Hercules culture. Femininity and sexuality do not seem to hinder scientific acknowledgement for which comments concerning a woman's appearance are not necessarily perceived as discriminatory – in the more extreme cases female physicists can even find that their femininity may be used as an asset:

> Interviewer: *Do you think that your career would have changed if you had been a man?*
> P58, F: *Honestly, I have to say that when a committee to guarantee the same possibilities to men and women was created also here in this institution, many female colleagues came to me and asked me "when do you begin?/when do you travel abroad?", but I think I have never been discriminated, on the contrary I had some advantages because in a surrounding where they are all men, there is always some kind of pleasure in being kind to a woman, in giving her a bonus, in making her a favour. So there was no discrimination towards me. I remember that I had a female university mate who always opened a button more in her blouse when she sits for an exam and she used to say: "Look, this is a point more that I get", it is not always like this but sometimes you can – in a surrounding where there are a lot of men, there are advantages for a woman, but there can also be some disadvantages.*

In the Caretakers culture, the evenness of genders, as well as the more traditional gender roles are accepted as integral elements of the physics

environment for which gender does not become an element in the competition, as we have seen is the case in the Hercules culture.

> F, DK: *I'm a woman and they're men and we are allowed to be that. But I never connect that with work.*
> Interviewer: *So there was room for you to be a woman? It's not that people are almost neuter?*
> F, DK: *No, not at all. I think it's lovely that we're so many women in the group; that we're so many women here.*
> (Hasse, Sinding and Trentemøller 2008b, 112)

Put differently, gender may play a less determining role in this culture context because Caretakers do not only see physicists as professional colleagues but take account of all the features of a person, including political views, clothing, hair styles, hobbies and gender. In contrast to Hercules physicists, Caretaker physicists encompass both masculine and feminine characteristics and are thus less gender biased.

5.6 Summing up

In the Caretaker physicists' activity we can identify a number of cultural models for how one should relate to physics, what kind of identity formation is the ideal, how one should act in competition, what kind of power relations are preferable and how one should view gender. For Caretakers, physics is everything in their life if it is socially acceptable to either, or both, the group and to a wider societal context. The focus on the workplace identity is primarily on the group and within the group. Caretakers do not compete with each other. The group has an internal power structure, where young members must earn their group position by working their way up. But once they are accepted they can discuss and even guide the leaders. Gender is not used in competition, and group members are accepted irrespective of their sex. Since family obligations are perceived as possible to integrate in the work place activities, children and childcare are not seen as taking away time from the physics activity.

6.0 Worker Bees: The Diligent Physicists

In the analysis of the Worker Bee culture we find two ideal type physicists in one ideal type culture. On the one hand, we have the Worker Bees types and, on the other hand, we have the prime movers (the Hercules types) of the activity in this culture. We have found it necessary to include both types in the Worker Bee culture because the connections of acceptable and unacceptable conduct within this culture differ depending on one's degree of power.

The Worker Bees care for physics as a science, but they approach work primarily as a duty – a duty to which they can be highly dedicated. But they basically view their work in the activity of physics as a job like any other. They thrive best on clear tasks that enable them to see results in their everyday work. They often take pride in performing well and they appreciate recognition for their efforts and constructive feed back from the boss.

Worker Bees in a Worker Bee culture do not expect to take independent decisions, and are therefore dependent on someone to assign tasks. The boss defines the direction of the research work in general as well as the individual Worker Bee's connection to the workplace and tasks. The Worker Bee groups consist hierarchically of many diligent workers managed by an often very distant but assertive Hercules type boss.

The Worker Bees tend to acknowledge that physics is a profession with strong competition, but they do not regard this competition as connected to their own work place situation. Competition takes places among the distant Hercules leaders. The clusters of connections that define important elements for the Worker Bee are in short a fair and reliable boss, orderly collegial relations, satisfactory working conditions and time for family and friends as they erect a dividing line between public work life activity and private family time.

6.1 Relation to physics

The Worker Bee type differs from both the Hercules and the Caretaker types in the sense that their path to physics has been more coincidental.

Moreover, Worker Bees do not express the same intrinsic love and devotion for physics and physics research as the two other ideal types. Contrary to Hercules and Caretakers, Worker Bees do not feel 'destined' to become a physicist. What leads them into physics might be more coincidental and may be connected to encouragement from family members, school or university teachers.

> P175, F: *From seventh grade to ninth grade I just learnt by heart. I had no special interest in it [physics], I was just good at it, but (...) I developed a serious interest in physics because I had a really great teacher. (...) [A]nd then I (...) decided that I would go to study physics. Because I felt so good in that class, maybe, I don't know, maybe it was because of the teacher, maybe it wasn't because of physics. [Laughs] I don't know.*

> P15, F: *I am glad I finished it [i.e. physics]; I just never felt like it was really right. (...) One could also ask oneself [that] when it did not feel right why did I go into it? I think [it] was because of all of that with the diligent student – the extremely diligent – and therefore I did well, I got good grades. (...) [O]ne day my supervisor asked me if I had seen these scholarships that had been advertised, and then it (...) was natural to say "why not", when I happened to be one of the good, diligent girls, and just continue, even though I had not considered what to do with it.*

Worker Bees do not express a passion for physics as we have encountered in the Hercules and Caretaker culture. Instead, being engaged in physics is more perceived to be a profession.

> P174, F: *I didn't care.*
> Interviewer: *Why's that?*
> P174, F: *Because I don't feel like it was my work. And I don't care. (...) I don't deny that may be I wasn't passionate about it [physics research] anyway, I might not have had enough curiosity, (...) it might be that because I wasn't that interested, that curious, I never spent hours and hours [being] completely absorbed by what I was*

> *doing, so maybe I simply did not have this passion, the curiosity, maybe I did not have what it takes to do research.*

Here we see that passion for physics can be closely connected with the willingness to spend numerous hours at work. In that respect, the quotations reveals that the informant is part of a Hercules culture where being absorbed by physics is the norm rather than the Caretaker culture, where passion and curiosity do not entail having physics as the sole purpose in life.

In contrast to Hercules, they do not believe in disregarding the family or hobbies to be fully encompassed by the physics activity.

> P175, F: *[B]eing involved in science means that you'll be working in your office behind a piece of testing equipment for the whole day, then you, well – you'll go, how should I put it, soft in the head. That is, you sort of lose proper contact with the rest of the world.*

To avoid losing contact with family and friends, the Worker Bees stress having time for other activities outside the world of physics, especially time for the family.

> P175, F: *I have to start a family and raise children and everything. And I can't give 80 hours a week. It is like, never, I can't, and it, if I have decided from the get-go that there is no hope for me, well that is then (...) it is like a job for me (...) I don't expect to win a Nobel Prize or anything. (...) [F]or me family still comes first.*

In this description of a workplace culture, the Hercules value of being fully encompassed in the physics bubble seems to be the dominant norm (Worker Bees typically have Hercules bosses) and in this case it pushes functioning physicists out of the research environment. It also illustrates that if a situation at work forces Worker Bees to choose between the expectation of their colleagues or boss and their considerations for the family, they will always aim at meeting the expectations of the family.

Working conditions are generally of much interest for the Worker Bees – both in terms of material equipment, salary and work descriptions. This physicist changed work because *"it was really the clearer job description. (...)The salary in relation to my duties was another reason"* (P165, M). Among Worker Bees, working conditions seems to be rated as important as achieving scientific results. Since doing physics is (contrary to the Hercules and Caretaker types) considered to be a job among other jobs, the pay becomes a decisive factor. In rare cases, Worker Bee physicists actually chose to become physicists *because* of the pay. Though most Worker Bees take pride in working hard, the reward can be the salary rather than the scientific development.

> P175, F: *I had this course mate. He told me that he worked [at the institute], and then I said I would be interested in it as well, right – and you know, I didn't go there to pursue physics or something. I have to admit that I wasn't even interested in what I would be doing. That young man just said that he gets [a good salary] and at that moment I was really like "oh yeah, I'd like to get some money as well". (...) Anyway, I've done such a great amount of work, and I've found out so little, that I'm a little bit disappointed, but well, that's the way it is.*
> Interviewer: *And how do you hope to contribute to physics as a scientific discipline?*
> P175, F: *I don't. I'll be honest, I don't (...) if I wanted to achieve anything at all, then I would have to work 80 hours a week, well, (...) I would basically be living there.*

However, Worker Bees generally acknowledge that being a physicist is not well paid. What seems even more important than money is, therefore, to have a stable and tranquil work life.

> P93, F: *[W]orking at the university is comfortable, it is a very quiet job, there is a regular salary. Once in a while – once a year is enough – I would publish something. [It] really doesn't have to be super magazines, and this is very quiet. There is a group of people who feel comfortable with it. The salary is small, and they complain*

> *about that, but they do nothing to change it. They don't try (...) to go somewhere, or do anything else, or find an extra job. So, they are dissatisfied, but they stay, for they feel good about it.*

Worker Bees want to feel secure in their job and in the interviews they keep coming back to the necessity of job security. This is a recurring problem throughout physics *as* culture – but a most salient problem for Worker Bees.

> P190, F: *We, like, get everything done, everyone do what they can and, like, there's no terrible keeping of secrets from each other, or covering up or trying to make others do things, we have none of that. It's very positive. But namely for that, so for my sense of security, so that one day I wouldn't have nothing in my pockets, maybe I'm a person who worries too much also, I do this other work and that's like the thing that takes up more of my free time than I would like it did, so if I was more certain, and I can't even divide this here, this flaw between the system of financing science and my own need for security. So if I knew that I would receive this money for the rest of my life, the money I get from [the physics institute] right now, then I would quit this data processing job, I would quit this other job.*

A Worker Bee may be sitting at work late in the evening to finish a work task, but not night after night. Leaving physics research becomes an attractive option when the scientific work (long hours) threatens the family life or when the working conditions and pay deteriorate. The constant workload coupled with the need to compete is seen as strenuous by Worker Bees.

> P165, M: *I had done research for quite a long time and in some ways it's really hard. (...) [I]n my opinion the fact that you've never done enough, it starts to get to you over time. (...) That, that no matter how fast you do things, you should always have been able to do more. And immediately when something is ready to be published,*

the next thing should be in full fight. (...) And you always compete with your colleagues on who advances the fastest

6.2 Workplace identity

As in the description of the Caretaker type, we refer to Worker Bees in plural. In spite of acknowledging the effort of the group, Worker Bees' focus and motivation is on their own task as an isolated contribution. They have the ability to work as 'individuals' in a group by strictly following instructions from above and fulfilling them individually. In some respects, the type of tasks handled by Worker Bees does not invite close collaboration but individual work efforts.

P28, F: *There was a lot of fieldwork in the beginning where there was also a lot of practical work, and then afterwards it became more and more theoretical, and it became too lonely at times. (...) I wanted to work more in teams with other people. (...) But during my PhD and while I was working at [X] I mostly worked alone. The topic was really interesting, (...) but the form of work was simply too lonely.*

The Worker Bees differ from the Caretakers in the sense that the Worker Bees predominantly form professional relations, i.e. they perform the work expected in the group and acknowledge the necessity of a group effort, but do not otherwise invest time or personal interest in their colleagues. Consequently, Worker Bees rarely feel obliged by social ties.

P23, M: *Sometimes when people from the outside come into the institute they ask if there's a major holiday or something like that. (...)*
Interviewer: *There aren't a lot of social activities here?*
P23, M: *No. Not really. (...)*
Interviewer: *Is it a lonely job?*
P23, M: *It might be, but that's something I seek myself. It always has been. I've never minded sitting on my own.*

However, the absence of social interaction in this scientific culture, can lead some Worker Bees to feel too lonely:

> P196, M: *I did lots of thing then, enormous work. But it was unpleasant work. To do such unpleasant things years after years and all alone (...) I'm one of those people who love cooperation. It's terribly important for me that I can discuss things.*
> Interviewer: *But what about group work?*
> P196, M: *But the groups were simply very small and everyone minded their own business.*

Worker Bees generally prefer a quiet working environment and one way of not getting in trouble at work is (in the Worker Bee culture) to avoid being noticed negatively by the boss. Thus, rather than being noticed as playful fighters, emphasis is on not standing out.

> P98, M: *But in this respect, for us not to show ourselves too much and do no crazy things, we had to sit quiet and pretend we were not there.*

Another characteristic of the Worker Bee is the acknowledgement that one should never promote oneself and boast.

> P119, M: *No, there is nothing that would remind of Einstein among the physicists. If somebody did anything like it, they would be ridiculed, showing off like this.*

Because work place security is an aim in this culture, it can have the negative effect of preserving a 'static' environment where people accept fixed positions and do not come up with new ideas.

> P91, M: *There's no rotation, there's no exchange and consequently there is no impulse for a change. Less and less happens and the department is not able to function anymore. And such departments exist. Sometimes a decision is made to disband them, but some departments may function like this for several years. Especially when the boss is not charismatic and doesn't care, it's all the same*

> *to him, and he only wants to be done with his work, the family is already more important, he is a full professor already, and he doesn't give a damn, for he would not achieve anything more anyway, and this is a tragedy for a department.*

In line with not standing out, Worker Bees tend to define themselves as individuals but not independent scientists.

> P104, F: *Theoretically, it is so that a senior lecturer isn't an independent worker. So, of course his scientific work ought to be established by an independent worker; that is a boss.*

Due to the formal hierarchy of this scientific culture, Worker Bees express the conviction that it is better to leave work related decision to those in charge. In that sense independence is attributed to the bosses:

> P100, M: *[It] is the boss who offers and asks me if I want to go. Because you know, a topic is a topic and my boss knows (…) better which conference is good and what you can expect from it. So, I can say that there was only one initiative that came from me and the rest was my boss's initiative.*

> P148, F: *PhD students do what PhD supervisors say. Of course (…) the person him/herself has quite a lot of say in how it is done and what else could be interesting (…) but it is the supervisor who gives the overall subject, who says 'study this' and then it is done.*

Because the rank-and-file Worker Bees do not take independent decisions the boss greatly affects the individual Worker Bee's tasks and research area.

> P38, F: *The manager I used to work for has changed his field and wanted me to continue working with him, leaving therefore what I was doing. (…) I wanted to hold a neutral position anyway, as I did not think it was up to me to decide; the managers should manage and decide upon the best ways of assigning employees. I obviously*

expressed all my doubts, but I did not want to push neither way leaving it to those who were in charge.

Moreover, the overall direction of the research in the given group is highly influenced by the boss. The following quotation illustrates how the boss of a department influences both the overall research orientation and the individual scientist's relation to the work tasks:

P88, F: *[T]he range of our activity depended a bit on who the boss was. In the first period of my work, the department concentrated more on teaching classes, less on the scientific kind of work. We had seminars, internal professional training, but it was our boss at that time who payed more attention to it, perhaps because he was also achieving one level after another in this scientific career. However, later a change of boss took place and this [new] boss payed much attention to research work and he motivated us to do research work.*

The hierarchical structure in the Worker Bee culture promotes the meticulous work effort of the employees rather than attempts to be creative and innovative. In this sense, the playful and innovative games praised in the Hercules culture are suppressed by the boss in the Worker Bee culture. Instead, the willingness to work hard and the ability to work meticulously are a way to be noticed positively and move forward:

P102, M*: In order to be noticed here, one has to prove not only his/her abilities, but first and foremost willingness to work hard.*

Interviewer: *And what about personal traits? What do you think, are they important?*
P100, M: *Diligence for sure. That is, I don't know people who were not quite diligent and became successful. Decisively, this the most important feature. Diligence and perseverance because, generally speaking, the rest is not that important. Because, in fact, the rest is also important because it builds, let's say – . Well, you can't be a troublemaker, right?*

In the Worker Bee culture, the boss takes on the role of the innovator and creator. Because the division of work in the Worker Bee culture is one where the leaders think of new research ideas and associated tasks and the Worker Bee scientists follow instructions on how to carry out these research tasks, the Worker Bee scientists prefer well-defined work tasks.

> P40, M: *[M]ost of the times I am working because someone (...) asked something well-defined and which I, I can discuss, I can contribute in terms of (...) doing it the best I can, while how to do it (...) has already been decided and it came from a researcher.*

Moreover, the Worker Bees' needs and desires to see, preferably daily, results and impact of their work efforts suits the distribution of work that leaves the more administrative and in some cases routine research work tasks to be solved by the Worker Bee scientists.

> P15, F: *I like being service minded, (...) I like when my boss or some of the others come and ask me "can you create a website", "can you take care of that", "can you do this", "yes, I will". I like that, because then I can see an instant, within a relatively short time, I can see the result of my work, instead of sitting alone at a desk or sitting alone in front of a PC and think "wow, how am I going to solve this", while others just sit down and do it.*

Since Worker Bees (like Hercules, but unlike Caretakers) rarely consult each other for assistance in carrying out the work they are very dependent on instruction and guidance of their superiors. If this guidance is lacking they tend feel at a loss and, as described above, isolated or lonely.

> P117, M: *His role was to come here, sit for two or three hours and go home, as it was a more experimental part. So, he came to a conclusion that it didn't make any sense because if there was nobody controlling him and telling him what to do, he was just simply wasting his whole week. He really disapproved of it. (...) He*

ended up as a computer programmer. He is satisfied – he goes to work at 8.15, finishes at 4 pm and he says that he is really glad about it. He doesn't waste his time unproductively.

P110, F: *I used to have, say, small crises for a long time during my doctoral degree, when nothing was working out, when I felt very lonely, because I happened to have a supervisor who(…) simply taught being independent by leaving one totally alone.*

Some do not feel responsible that the work is done if their efforts are not monitored by the head of the group.

P193, F: *[O]ur work is for the most part individual (…) this management, in the old days, limited itself to checking work discipline, i.e. whether or not you were present, when it was work time. (…)[I]in the morning, when you stayed above the line, then during the day you could just polish your nails here or do anything, this was no longer checked so very much.*

In that respect, and coupled with the wish for a tranquil work life, the Worker Bee is not a fighter in physics:

P103, F: *Self-confidence, this sort of spark, the ability to fight one's way through. I've never been like that (…). I cannot learn it, because it's not something one can learn.*

P103 (F) continues that she is *"not that much devoted to science"* and would rather see herself by the *"production line. (…) Because of the fact that I don't have this determination to fight my way through life, and other features of character like that. So I would rather see myself as one of these 'ants', as someone who does something specific, knows it well, is able to implement it, explain it to people and does his job conscientiously"*.

This may not be a Nobel Prize winning type of research work but a necessary part of the research environment.

In terms of work related feedback and appreciation, the Worker Bees would feel more content in a Caretaker culture compared to a Hercules culture where feedback and appreciation is a given. Unlike Hercules, Worker Bees express discontent if their efforts are not recognized by the boss (who is typically a Hercules type).

> P87, M: *[T]his amount of time was enough for me, for my family, for my home. However, I worked a lot on a voluntary basis (...) [W]hen everybody was taking days off, while I used to sit for hours in (...) office, of course, without a "thank you", since nobody was able to say "thank you", and it was very time-consuming. One puts the whole heart into it (...) and this took a lot of time. It took me 19 years and this was a community service, no one said "thanks".*

It is simply frustrating for the Worker Bees when their good work is not acknowledged.

> P110, F: *I am motivated when there is something which motivates me. Such character trait, characteristic for women, I believe. When my boss is not interested in what I do for months, it is de-motivating for me. And on the other hand, it is very easy to motivate me (...).*

> P93, F: *[T]here is, for instance, a whole group of frustrated people, who, (...) don't feel like doing more. And I also had such acquaintances, [a person] who were able to come and say that what I was doing wasn't worth anything, that no one cared about it. [So] why do it at all?*

The wish for appreciation and need to see results may be connected with the Worker Bee's relationship to work; that the research is not their own creations but tasks they conduct for the boss.

> P15, F: *I got a job at the university here, then I knew that I had entered the right thing. Because now when I was working people said thank you for your help, we can see this, we can use this, hooray, right. Instead of for me, research was always like two steps*

forward and one back, and it could be two weeks work where one week had to be redone, two months work where one did not get give any results. So this constant dissatisfaction, the way I felt with research, it was extremely demanding, and it was extremely hard.

6.3 Competition

In relation to the cultural model of competition we find a clear connection between the types of accepted or expected conduct and one's level of power. The large group of Worker Bees connects very differently to competition compared to the small group of Hercules bosses:

P111, F: *There were some sort of social relations with both groups, with people who were trying to make a career somewhere else and with people who sat there, drank their tea and did nothing.*

The Worker Bees generally do not consider themselves sufficiently equipped or passionate enough to enter into, or win, fierce competition. Instead they prefer focussed but peaceful work procedures, in which respect they resemble the Caretakers.

P15, F: *I have always thought that I do not have the courage to meet with them [indefinable competitors] because I am just different from them. (...) I am not made for doing research. I do not have this drive where you do not question it, where you just continue as if it is the best thing in the world. (...) I think it is (...) mainly because (...) I was a little, studious student at school and everything, but I just do not have the motivation or the interest or the elbows or the drive or the enterprise or – I easily let myself be knocked out. (...) [W]hen I get a new assignment I always think "Oh no, how will I manage that" and things like that, but then slowly I manage anyway.*

In the Caretaker culture, such feelings of inadequacy would have been taken care of by the group, but with the Hercules type boss the Worker

Bees are not reassured which is pointed to as a reason for leaving academia for the benefit of a less competitive environment.

> P175, F: *And at the same time it's also, that terrible – the self-esteem goes through a serious slump. Well, with science there's also, the problem is that there's always the feeling that you don't know anything. And then, when you're a university teacher, then you, then your self-esteem somehow – increases, and then you see that I actually can do it and I'm also valuable.*

In some cases, Worker Bee physicists may be so uninterested in competing that they do not notice the competition among other physicists in their proximal working environment.

> Interviewer: *Did it seem that at your workplace, during the physics period, there was fierce competition between each other?*
> P202, F: *No, it didn't.*

> P128, F: *Well, there certainly was some rivalry, and these were certainly some projects, some grants, and there might have been some competition, but it was quite natural in my opinion. Not [like] someone setting traps, or something. No, I know nothing about anything of that sort.*

If they do notice, Worker Bees will stay out of it because they believe they do not have what it takes or because they can see it would interfere with their private life.

> P124, F: *I suppose [the competition] is not that strong. It is not so here. We are not so numerous [at the] institute and some things are taken care of in a more natural way because I will not compete against somebody if it could negatively influence my home or family matters.*

Furthermore, in situations where, a competition-oriented research leader encourages (out of force of habit) a competitive environment in the proximal environment, the Worker Bees will withdraw from this environment:

> P175, F: *Oh, when a situation arises in which I have to compete intensely with other people, then I – if the environment got too nerve-wracking, then I wouldn't be able to do this, I wouldn't be able to handle this. I like to work on my own. Let's say, even if there's a group, then this group cannot be such that, that everybody is competing with each other, everybody has to work towards the same goal and get on well with each other. But that all depends on the supervisor, because the supervisor could create a situation, or the boss or somebody, could create a situation in which he makes people compete with each other, because he thinks for some reason that it is more beneficial. But I, when such a situation arises, then I can't handle it, that's one of the things that can definitely have an impact on me.*

In contrast to the Hercules and to some extent the Caretaker culture, it is generally accepted in a Worker Bee culture if one has no intentions of striving for the top scientifically, but wishes to take up other roles in the research environment.

> F, FI: *[T]his upkeep of the measuring device net that are on my shoulders in such as large amount. It is because of, on the one hand that I'm not a very good researcher, but on the other hand that I'm so good at some of the practical side of things. And that has maybe allowed other researchers more freedom to just do research because I've been more in charge of these practical things (…) it has been easier for me, because I feel like that pressure of expectation isn't that great on me (…).*
> (Vainio 2008, 233)

Since Worker Bees have no intention of taking the lead in the race for new scientific results, cases of cheating or stealing is less widespread in

Worker Bee cultures compared to the Hercules culture and private enterprise, as the following quotations illustrates:

> P93, F: *They have a very big knowledge, they can solve problems. I think that, well, on the average, they are deprived of such faults like envy, for instance. For some kind of a trend in business is that here people are trying, I mean, beyond the average, to approve themselves, it leads to the fact that they very eagerly steal some ideas from others or they appropriate some achievements too. At the university, (...) because it's about having many of these works, while well, there also is a kind of honesty, that I can't appropriate one's work. It certainly happens that someone had an idea, [and] I used it, but it's not that often, I think.*

One of the reasons why there is no fight over scientific results in a Worker Bee culture is that the structure is an all dominant Hercules at the top managing the direction of the research in the Worker Bees group.

Furthermore unlike both the Caretaker and the Hercules culture, competing for top position also appears less attractive for the Worker Bee. In some cases the wish for a tranquil work life makes the Worker Bees refrain from entering into this type of competition:

> P125, F: *I will not use my elbows to get there, you know. What I mean is that now I don't need this possibility of being promoted. No. I don't know_ I wouldn't like to become the faculty dean or a prorector because it's not that kind of job that I would like to do.*

The Worker Bees are aware, however, that other cultures have other norms for competition. In their contrast with other cultures, the Worker Bees illustrate the connections within their own culture.

> P120, F: *Well, this is strange – if it were in the USA, we would probably fight and each of us wanted the other not to get the post. There is no such competition here.*

One of the reasons why physicists do not fight for positions in a Worker Bee culture is a history of promotions being given automatically.

> P134, F: *[I]t used to be automatic, you know, that one got the doctorate, one would become a research associate, well, and one could further to the [next step]. And if one didn't do that [take the next step], they weren't thrown out in any way, no.*

Yet, the following statements also indicate that though the line of promotion may follow a relatively automatic path, it can be dependent on the boss who is in power to promote and discharge:

> P121, F: *We are all equal in our unit and we have our boss above us. We are dependent on him in this respect that he has a decisive voice when it comes to prolonging our employment contracts. But generally it's that at the university there is a specific career mode, a defined career path (...). There are some requirements, a certain number of papers published and it's only my fault that I'm not complying with that (...) and my boss can only evaluate that. But it would be only his ill will if he wanted to sack me just like that, and it would be rather difficult for him to do it, I think.*

> P123, M: *[M]aybe these are comfortable conditions in which we don't have to – just in this negative sense – prove our superiority. Because we have to prove it to our dean-chancellor authorities, that we work here, you know, scientifically, there are publications. They look; 'Fine' – of this kind, yes, but it's positive. But we don't have to compete with each other here. If there is a need we can co-operate, if there is a need to do something alone, it's also possible (...) everyone can really find a place for themselves.*

It appears more relevant for Worker Bees to compete for funding than for a position or scientific results.

> P116, M: *Well, (...) I have no ambition of becoming a full professor or something like that. And looking at it closely, I suppose it would*

> *be more important if there was some financial aspect behind it, and whether I get something substantial. (...) So, promotion is not some kind of a doorplate for me, with some title.*

Efforts for ensuring funding are entrusted to the Hercules boss and possibly viewed as a distant fight, which does not interfere with the Worker Bees' everyday activity unless the boss is unable to provide results. Again the stress on the absence of scientific fights is noteworthy:

> P120, F: *We are fighting for grants and it is known that only one department will get a grant. So, in this sense there is a competition. Is there a scientific competition? I am afraid not, at least not at this department.*

The Worker Bee culture is, however, not entirely outside competition, rather the Hercules physicists situated in Worker Bee cultures compete from their position as head of a research groups or a department. Therefore we find descriptions of a more distant (but less hidden) type of competition in this scientific culture compared to the one identified in the Hercules culture.

> Interviewer: *But you said that physics – at least your work environment – wasn't very competitive?*
> P196, M: *(...) You see, the problem is, the question is actually very simple, why I never saw that competition, I didn't see it because it didn't take place on the spot, we were such a small unit and everyone was working on their area, because [the local boss] didn't fight here but with the foreign colleagues, right. You see, that's where the competition took place. (...) [T]here was competition (...) but it was outside and above my head at the time.*

At this level too, the Hercules bosses primarily fight for overall funding:

> P208, M: *Instead of positioning themselves in the world, the universities are still figuratively speaking fighting for the nickels that come from [our country]*.

The dependency of a group leader or a head of department also comes up in relation to competition because the boss alone fights on behalf of the Worker Bee physicists.

> P98, M: *[People on top] still have many contacts and connections (…). And for some time, they would set their sights on liquidating this branch of the institute. When the professor was gone, who had been a very strong personality, they were able to plot here, undermine all this existence of ours. And they succeeded to a large extent.*

Thus contrary to the Caretaker groups, we typically find a power structure within the Worker Bee groups that can be defined as "*one-man institutes*" (P208, M). Yet in the following case, we see an unusual situation in a Worker Bee culture as the institute is characteristic of three top people competing internally who simultaneously provide greater stability for the group members.

> P208, M: *It [the institute] has never been a one-man institute, because the institute was created to stand on three feet (…). These [people] have always been either competing (…). And because of that, this house is (…) a lot more sustainable, because it doesn't fall apart when the leader fails, because it has many leaders. Maybe all the leaders aren't from the highest category, but it has a completely different mental attitude and it's very good that it's like that.*

Because competition in the Worker Bee culture takes place at the top level only, the rumours of the conflicts are generally retold in the local department as a story from far away.

> P126, M: *As they say – if you don't know what it's about, it's about the money. And at one time, there even has been a rumour here about*

> *certain conflicts between people high in the hierarchy on the financial grounds, for some of them received more for research, others got less, so there will always be rivalry as far as this is concerned.*

Moreover, scenes of competition like "*animosities between the bosses"* (P114, F) tend to remain distant rumours because Worker Bees stay clear of interactions that jeopardize the tranquil worklife. As P114 (F) points out: *"I have no idea about it. I don't go to the department meetings, I don't participate in gatherings. I don't know."* A typical trait of the Worker Bees is to not get involved:

> P165, M: *I'm sure there were some things that went too far and in fact I don't even know it all and actually I never really even wanted to know. (...) In my opinion that sort of thing is not part of that kind of work (...) it's the professors that sit there who make the decisions. (...) And [laughter] there isn't much that those on lower levels can do. That it changes so slowly and what also happens is that the old disputes are taught to the followers. (...) People have a very long memory there. (...) It's all quite resentful. (...) So (...) in the end, the decision about transferring here was easy because these things started to get to me a little.*

6.4 Power relations

In this scientific culture, formal hierarchy carries the most weight. In contrast to Hercules and Caretakers, Worker Bees think of work in relation to a hierarchy of employees (workers) versus the boss. In that sense the boss is not head of a collaborating group, like in the case of the Caretakers; but the 'big boss' ensures that *"[r]esponsibilities are clearly defined*" (P145, M). Thus, when asked: *How would you describe the hierarchy at the Institute?*[29] Worker Bees tend to answer: "*You mean the relationship between the boss and the employees?*"

[29] See the full interview guide in *Draw the Line!* (Hasse, Sinding, and Trentemøller 2008a, 378*ff.*).

(P95, M), "*The hierarchy, meaning who rules, right? Well, the boss does, of course*" (P120, F) or "*I don't think there was any hierarchy, there was more or less the director of the department or the institute and all the others were practically subject to him*" (P200, F).

Worker Bees recognize intellectual, as well as formal superiority – but they rarely attribute intellectual superiority to themselves though they may have it and they tend to look to their boss for solutions. Worker Bees tend to stick to themselves and do not think their voice is decisive.

> P124, F: *No, I do not get [involved] after coming back. Because the professors tend to have their own mind and I know that our boss fights this kind of attitude. (...) We work like this: we choose our representatives. There is a (...) commission and the members of this commission (...) have to decide about it. Sometimes they send some signals down, that something does not work correctly. Me, for example, I don't refer to this because I think that my opinion as a woman does not mean much. If it was a person more of my circle of colleagues, so to speak, then yes. And so you can say something in a meeting, some faculty meeting. But I am not particularly involved these days.*

It is generally agreed upon that those in power undertake responsibility of making decisions:

> P208, M: *Someone has to make the decisions in a research group. Of course, they are discussed, debated whatever, but someone still has to make the decision.*

This division of work and power results in a work culture in which the Worker Bees are reluctant to challenge or question the boss. Instead Worker Bees respect authority, which is very unlike the anti-authoritarian Hercules and the group-oriented Caretakers.

> P114, F: *And my boss doesn't really care about it. It has to be like this, and this it is. If you don't like the classes you can look for a job somewhere else. This is simply the policy.*

> P125, F: *My boss was quite imperious. He didn't like people to take independent decisions. He preferred everything to depend on him.*

> P112, M: *[T]hese people would be quickly promoted since such people like me were employed* to do *things there; you know [to do the dirty work]. They would only put all this together. The cover would be with their names on, and that's how it all would go. So this hierarchical system was terribly sort of, you know, obvious (...). There wasn't even any point in thinking about how to evade something in some way. It was impossible. It would repress every initiative.*

In this scientific culture, the younger Worker Bees are not praised for being creative. Here, a Worker Bee's creativity might be seen as an annoying challenge to the authority of the leadership.

Like the physicist quoted below, Worker Bees generally accept the hierarchical structure even if those in power may act in an unreasonable manner:

> P103, F: *Well, it wasn't that bad, because there were people who were open to what a young man was doing, (...) and it wasn't the way that they wanted to ground us, and show who's the boss. And at least, not all of them behaved in a supercilious manner; that's why there was this huge gap between us and the professors.*

Yet, as the statements below indicate, Worker Bees do not approve of a leaders' lack of trust or commanding enforcement of power:

> P193, F: *When I was young, we still worked in X, then we had a very strict work discipline and that sometimes did make me angry. [W]e had to be there eight o'clock in the morning, let's say, maybe it also was 8.32, I can't remember exactly. And then the boss came, drew a red line and those who remained below the line had to write a letter*

of explanation. Well, leaving the work was like, well, if you left earlier, you could get into trouble (…) so you (…) were supposed to be there very late; otherwise you weren't dedicated enough (…). [W]ell in short, there was this kind of a control on the work regime.

P111, F: *I unfortunately had to sign the list of attendance, but it was not strictly obeyed and in fact I could leave whenever I wanted. I mean, when I had an argument with my first [boss], well, then he made sure I stayed there from the start till the end of the working day. And next, when I had the other boss and our relations were sort of gentlemanly. I used to start and finish my work when I wanted. Or sometime, I didn't come to work at all. Everything depended on the relations with the boss.*

Because this type of formal hierarchy tends to furnish the leader with a high degree of power, the Worker Bees always have to stay attentive to the relation between boss and employee.

P206, M: *What could be [the worst thing] is when my direct superior, dean, wouldn't trust me. This would be a serious problem.*
Interviewer: *Does he trust you?*
P206, M: *Yes, he trusts me. Let's say that we don't have – I mean, there are no restricted areas between us, at least it seems to me. We talk openly about everything and the dean trusts me easily with the things that don't necessarily need his presence. Well, let's say that distrust is – I have had to tolerate it a little and I know what it feels like. It is most unpleasant when your boss so to say doesn't – may in reality not do what was agreed but something completely different and – well, what's there to do.*

Due to the clear division of power in the Worker Bee culture, the physicists are not surprised by dominant leaders who might at times act in unreasonable manners. Instead the Worker Bees stay attentive to possible changes of the boss' mode of mind as they are aware that privileges and opportunities can be removed.

P110, F: *And one hears often that a boss was furious when one of his employees gets pregnant, or that scientific bosses are furious, it was completely different in my case. My boss was very happy, and friendly, and I didn't have an impression that he was furious at all. And then he treated me in a friendly way, showed me his understanding. I don't know how long he will be that patient.*

P121, F: *[H]e can also say to me: 'I will not give you any money for the conference' – as he also manages financial matters. 'Because you don't have any achievements', as he once told me. 'You haven't had any achievements, so you won't go to this conference'. Full stop.*

But because standing out negatively can involve high risk in this culture, Worker Bees do not try to change anything by challenging their superiors.

Interviewer: Have *you ever tried to change this or something else? With what result?*
P87, M: *Not really, I didn't particularly stick my neck out [smiles] purposefully, because I knew what the hazard it was in the old times. Now also, not much has changed, I would say it's even worse. (...) I carried out tasks, did my duty.*

And the boss is never questioned.

P87, M: *I feel sorry that such changes have taken place to the disadvantage of physics itself, because at one time there was very intensive research here (...). And there was a chance of great development, but the connections determined that they got rid of a person who could have a huge influence, well, such were the deals. "I, the boss, am always right". (...) Relatively young people, even quite good, but their conditions created by their bosses were such that they had to go. There are a few people who had to leave not due to the lack of knowledge or involvement, but beause of the deals, because the smiles were not as they should be.*

As in the cases above, we find examples in the Worker Bee culture of the formal hierarchical division of labour resembling an autocracy:

> P194, M: *There was just one leader and teacher and that was it. (...) Even when somebody was named the director of the laboratory, the director of the institute was still [the local boss]. So, that didn't change anything. [He] was the person who made the end decisions, right. . (...) [A]t the time it didn't concern science at all.*

But if the leadership is too unreasonable, a Worker Bee will feel that work-related problems interfere too much with everyday life, and that may lead him to leave the workplace:

> P88, F: *In the time when I was taking up the decision to resign it was because of interpersonal relationships in the department. Actually, the inability for the boss to cope with the team, hence the unhealthy atmosphere at work, and instead, so to speak, feel so uncomfortable with all this, I concluded I could change my job for a more satisfying one.*

Through the data material we also find examples of young up-and-coming Hercules types in Worker Bee cultures. Below, a physicist explains how a young Hercules can move to the top in a group of Worker Bees dominated by other Hercules types by 'surpassing' the local environment.

> P111, F*: Oh God, there were actually two types of people there. One type consisted of people who treated science as an ordinary profession, not for the purpose of making any career, but just to have a post (...) I said that there was hardly anyone in this Department of Theoretical Physics who would make any career. Now, I remembered that I had a colleague who was hardly ever there, who just treated [X] as a temporary place because he didn't have any permanent post at [Y], but he used to write scientific papers, i.e. publications. He was writing papers with people from [Y] and he was forming some scientific groups with people from [Y]. So, there were actually people who wanted to make a career, but they were always making it outside [P].*

Unlike a young Worker Bee or Caretaker, a young Hercules will fight and challenge the power of the leader.

> P200, F: *When one person gets to decide too much, then this – and the opinions clash. And then it's often that there's nothing you can do. Then you simply have to fight or find another way, when you can't go on like that.*

In a Worker Bee culture, a young Hercules will strive to reach the top, but the fight might be harder than in a Hercules culture, because there are few positions, and the 'old guys' (i.e. Hercules leaders) tend to fear that younger physicists will take their place. Instead of helping a possible protégé in a personal relation, they suppress up-and-coming Hercules physicists even when they work within their jurisdiction. This is why the most likely way to the top is 'going around' the local environment.

> P98, M: *[X] had neglected a bit the shaping, training the young people who could take his place (...) For this is the kind of a feeling of these professors, (...) that "oh, they still have time to promote their followers, they wouldn't yet concentrate on it too much, for someone may want to take over".*

A local Hercules can be forced abroad by older, more powerful Hercules leaders, and are not welcomed, when they come back. As this physicist who relates the experience of his son, a young Hercules, who was bullied by elder colleagues, although he had won international prestige abroad. So in this culture (in contrast to the Hercules culture) international fame is seen more as a threat than an advantage.

> P209, M: *He had a wife and two children and one of the children was already going to school in [our country] and he probably would have come back on certain conditions but there's nothing to do about or – yes, things like that, yes. Reasons lie deep, you come here and become a competitor. But that's how it is. (...) [T]hat's one thing that sometimes really happens that they don't want to get the best physicists back anymore, because they're seen as competitors.*

6.5 Gender

In this culture, gender plays an almost non-existent role. Regardless of gender, anyone can count as a diligent Worker Bee. The female Hercules leaders are 'protected' by the distinctions (titles, awards etc.) within the culture, which ensure that Worker Bees always respect a superior, irrespective of gender.

There might be strong gender roles, but because physicists do not compete, their gender is not used as a competitive element (like it can be in a Hercules culture). We find that the Hercules physicists in Worker Bee cultures can be male as well as female, which is also clear from some of the quotes above. This might be due to the hierarchical system and the acknowledgement (which would not be accepted in a Hercules culture) that the higher you rise in the hierarchy, the greater your intellectual superiority.

> P88, F: *As I feel, it didn't. Gender does not play a significant role to me, whether the boss is a man or a woman. A woman can be an intellectual superior just as a man.*

> P206, M: *(...) I think that [gender] doesn't matter. Because that still – yes, I think that it doesn't matter. Because when, when someone is intellectually superior to you, then you try – well, I mean, it seems kind of inevitable that the relationship is first of all intellectual and won't turn into a relationship between a man and a woman – I can't imagine how this could happen.*

Even so, in a Worker Bee culture where all positions are fixed, we can also find indications of very fixed gender roles, which spill over in work place relations.

> P88, F: *However I feel it, at least the boss expected of me total acceptance of his every blunder, pardon me. I feel that if someone was a man he could object to something, while I had no right to. I don't know, he treated me as a wife at home, who had to listen to him. Such was my impression. I mean, I can't say it was always like that,*

for he respected my opinion, I can't say, but since he respected my opinion, this was one of the causes for conflicts within the team and he couldn't behave as a boss should. He even contributed to worsening these conflicts instead of putting an end to all this. And since I was the only woman there, so once I noticed that one of my colleagues is not fair to me, the boss accepts it, what more can I do there, then.

A Hercules boss might, if he is a man, feel less threatened by a woman.

P125, F: *Yes, I can say that [this] professor was such a mentor for me. He was here for many years. (..) I worked with him for thirty years or so. He was the boss here and decided about everything.*
Interviewer: *And the fact that he was a man, did it matter at all?*
P125, F: *Oh yes, it did. It was easier for me because I was a woman. He tended to collaborate better with women than with men. Sometimes he clashed and wrestled really hard with other men. So I think it did matter.*

This young male has some problems with his boss.

P196, M: *I have loads of ideas but they're not needed. Because, how to put it, I have some discords with [my boss], because there were two students once I had to supervise. I went abroad and left it up to someone else to supervise and everything would have been fine, but they proved to be lazybones and blamed everything on me and now [my boss] thinks I'm to be blamed because those two didn't graduate in time then. (...) And if [my boss] has that kind of attitude, like [being] the most important one in deciding, [my boss is] quite a smart person, but I'd say, [my bosses] attitude is, that I'm not the right guy and I don't feel like falling into arguments about that.*

In this quote we have exchanged 'she' with 'my boss' and as in this example we find many examples where it is natural for male informants to have a female boss, that it is not mentioned that she is female and if

we did not know, we would have guessed they talked about a male boss.

We find many examples of male physicists who give up competing or fighting against a male or female leader. Even so Worker Bees might be more easily associated with women, even by the female Worker Bees themselves.

> P104, F: *What I lack is this strong self-confidence, this ability to fight my way through life. That's it. Yes, men usually possess this feature. (...) [The] majority of women, before they say something, they try to think it over, check it, make sure if it's really the way they think it is. A man, however, is always very self-confident, even if he is wrong, and it is the way to win.*

6.6 Summing up

In the Worker Bee physicists' activity physics is *not* everything in their life. Their work place identity is to focus on the tasks belonging to the physics activity, though without it taking time from their private life with family and friends. They maintain a sharp dividing line between the private and public spheres. They are uninterested in competition and accept a formal hierarchy where the leader delegates work tasks. Gender relations are not used as an element in competition in this scientific culture.

7.0 Discussion and Conclusion

In the previous chapters, we have presented how, through the method of culture contrast, we have identified clusters of connections which generate cultural models. Initially we dealt with seemingly unconnected cultural models for entry requirements to physics at university level, concepts of family and influence of religion (physics *in* culture). Subsequently we described, and to some extent contrasted, the three ideal type scientific cultures that we have identified within physics *as* culture: Hercules, Caretakers and Worker Bees. Thus within our framework of analysis we have scrutinized the cultural models formed in national cultural historical activities and the cultural models formed in physics activities, but we have not yet contrasted or sought to combine the findings from these two analytical fields. In this chapter, we will attempt to combine the findings from the two analytical fields in one coherent analysis.

So far, the analyses in the national reports and in this publication strongly suggest that our results have wider implications than shedding light on gender diversity in physics. Yet, in line with the overall objective of UPGEM, this chapter will primarily seek to explain why we find cultural differences in the relative proportion of female physicists in the five UPGEM countries.

Firstly, we offer a tentative answer to the question by outlining the factors identified as belonging to the realm outside the discipline of physics. We shall briefly connect these discussions with the explanations put forth in the introductory chapter. We exemplify the analysis by the two countries which represent the extreme ends of the scale of representation of female professors in physics, namely Denmark and Italy.

Secondly, we explain why we find this approach insufficient and shift our analytical focus to a discussion of the relation between women and the three ideal type scientific cultures. Within the framework of physics *as* culture, we point to cultural models indicating that women may thrive better in some of the ideal type scientific cultures.

Our third step is to combine our culture contrast method with empirical data and the motives defined as directive for action in the

ideal type scientific culture. This is exemplified by a re-analysis of sexual harassment, which was first discussed in the individual national reports[30]. By way of this and other examples, we will combine the discussed cultural models from the scientific cultures with the national cultures. In our attempts to combine the two fields, we take account of gender issues but focus particularly on why women may be discouraged from pursuing careers in physics.

Following this discussion, we offer our view on a new way to work with the activity theory and the theory of cultural models in combination. In this connection, we also argue that gender, as it is constructed in the different scientific and national cultures, cannot be confined to a cultural model of gender (i.e. putting gender first). We find that gender is ascribed meaning by the cultural models rather than gender ascribing meaning. For instance, we find unexplainable patterns of difference in the culture types in which women seem to connect with physics in unproblematic manners. Though developing new perspectives on gender theory does not fall within the scope of this project, we will briefly discuss how our analytical approach to gender may contribute to existing gender theories.

Lastly, we will end on a more speculative note as we briefly touch on some of the wider implications of our analytical frame, such as how universities as workplaces can been seen as embedded in two types of society – a 'Gender Society' and a 'Class Society' and how this affects gendered career paths.

[30] See *The Full Collection of National Reports*

7.1 Cultural models in national cultures

The project 'Understanding Puzzles in the Gendered European Map' takes its point of departure in the significant under-representation of female scientists at European universities and research institutions in the field of physics. Over the coming decades, the general decrease in populations will affect all sectors of higher education and research in Europe. Natural sciences are already encountering increasing problems with recruitment, especially of female physics students. Therefore, it is a matter of utmost concern that well-qualified female scientists, in comparison to their male peers, seldom reach top positions but often leave the academic research environment. This is a fact that has been well-established in a number of studies, notably the Helsinki Group Reports (Rees 2002), SHE-figures, the ETAN- and ENWISE Reports (European Commission 2000; European Commission 2003; European Commission 2004a; European Commission 2004b; European Commission 2005; European Commission 2006, European Commission 2008). Furthermore, these statistical surveys show that the representation of female scientists at universities is geographically uneven across the European nations; we find low representation in the North and a higher one in the South and East. We see that in the eastern European countries this stronghold of women in physics might gradually change to the worse. We cannot explain these differences in representation, but can we learn from the countries with a high representation of female physicists?

In the UPGEM project, Italy constitutes a 'best case' regarding the representation of female physicists while Denmark represents the 'worst case'. As noted in the introductory chapter, we have found the highest proportion of female associate professors (33%) and professors (23%) in physics in Italy and the lowest percentage of female associate professors (10%) and professors (3%) in physics in Denmark (Svinth 2008, 41). Moreover, we see that both in Denmark and Italy the ratio of men and women at enrolment at university decreases the closer they get to the level of professorships. In other words, the closer to the top academic positions the wider the gap between the number of men and women in physics. Graphically, this can be represented in the form of a

diagram shaped like a pair of scissors illustrated in a number of surveys made by EU. From these scissors diagrams we know that as a general pattern in Europe women do not move up through the echelons of scientific careers in the same way as their male peers and the gender imbalance exists, in varying degrees in all the European countries surveyed by the Helsinki Group (Rees 2002). As mentioned in the introductory chapter, this situation was coined metaphorically as the *leaky pipeline* by Joe Alper in 1993. The background for using this metaphor is among other places highlighted in the ETAN report on women and science (European Commission 2000). We see that regardless of the academic discipline, the proportion of women among undergraduates or equality measures, a greater leakage of women than men from science at every stage of the academic hierarchy in Europe. Though 'ENWISE-countries' (European Commission 2003) apparently have a higher representation of women among scientists than is generally found in Europe, the women are still underrepresented at the level of top positions in academia in these countries. Furthermore, the period of transition from the old, centralist system to the modern, market driven economies seems to have affected female scientists' careers negatively.

Another metaphor describing women's difficulties advancing professionally is the notion of the 'glass ceiling'. It has been discussed, among others, by Sue V. Rosser who as a scientist and university administrator made an email survey among fellow female scientists. The survey asks, among other questions, whether women hold themselves responsible for questioning whether they "can have a successful, happy career in academia" (Rosser 2004, 13). Rosser's analysis, as many other analyses on this matter, presented a mix of factual numbers and personal statements that serve to document that metaphorically speaking women hit an invisible layer of impenetrable obstruction when they try to obtain top academic positions (in science).

In spite of the general pattern in science in Europe, an interesting formation of cultural diversity appears when we look at the gendered European map of physicists. It seems comparatively easier to attract female students in eastern and southern European countries than in the North, and career paths seem to follow different patterns. Though it is

not a clear cut pattern we do find more female physicists in countries like Italy, Spain and Portugal and fewer the further to the North we look (Svinth 2008). The quantitative studies in UPGEM largely support this pattern as we also find the highest representation of female physicists in Italy followed by Poland, then Finland, Estonia and in the bottom Denmark.

As we saw in the introductory chapter, many of the reasons listed as explanations tend to concentrate on cultural aspects found outside the discipline of physics. Though the numbers in UPGEM confirm the scissors diagram, they do not support the simple correlation between the number of female physicist students and the number of female professors. The UPGEM countries with the most female physics students (Italy and Poland) do have the highest number of female professors. However, the UPGEM country, Finland, with the lowest number of female physics students does not have the lowest number of female professors (the intake of female physics students at universities in Denmark is higher than the intake in Finland, but the number of female professors is lower in Denmark). Looking at all the above numerical comparisons and explanations collectively, we find indications that:

A. National cultures can influence the intake of female students.
B. Physics cultures manage the intake of female physicist students differently; in some countries the blades in the scissors diagrams are wider than in others.
C. Women have problems reaching top academic positions in all the UPGEM countries.

In the UPGEM project we have not looked specifically at national differences in educational systems (though some information of this issue is available in our information boxes at www.upgem.dk). In our interviews we have, however, asked our informants to describe (as a timeline) their path into physics starting from school background to university education and finally employment at university. In these statements we found stories supporting the notion of the classical physicist. As described in Chapter 3, the notion of the classical physicist mirrors a national cultural difference in the way Italians and

Danes perceive physics. The notion also shows that the connection between classical language studies and physics entails a gender dimension, as the majority of the Italian UPGEM informants who entered physics with a background in classical studies are women[31]. This fits our knowledge of gender biased university entry requirements. In Italy almost a third of a cohort in physics enters with a background in classical studies and less than a tenth of these are males (Hasse 2008, 124). Thus, this explanation can now be added to the list of reasons (first mentioned in the introductory chapter) to the cultural diversity in the proportion of female scientists:

- *Differences in university entry requirements*

Yet, we have also shown that, this cannot in itself explain why we find a higher percentage of female physicists in permanent positions in Italy, nor why we find more mother stayers among the Italian (and also the Polish) informants compared to the Danish (as well as the Finnish and Estonian) informants. In fact, the high percentage of mothers in the Italian data material came as a surprise as the birth rate in Italy is one of the lowest in Europe.

As argued in Chapter 3, this could be explained by the different cultural models for 'family' in Italy and Denmark, even though we find the most traditional gender roles in Italy (and Poland). In Italy (and to some degree also Poland) the extended family (basically the grand-parents) helps the woman whereby she is more free to fulfil workplace obligations. The less beneficial alternative is the reliance on negotiating childcare with her husband or to solely rely on the public childcare systems, as is the case in Denmark (as well as Finland and to some extent Estonia). Thus, we can add another explanation to the list:

- *Differences in conceptions of family*

Consequently the full list comprises the following explanations:

- Differences in perceptions of education (girls schools, compulsory teaching of physics).
- Differences in the economic development and the labour market.

[31] Of the 14 Italian informants who have entered physics with a classical background, the 9 are women.

- Differences in perception of class status in relation to gender.
- Differences in the prestige of science (and subsequently in the researchers' salaries).
- Differences in religious influence in Protestant and Catholic countries.
- Differences in state support of child care.
- *Differences in university entry requirements*
- *Differences in conceptions of family*

When we focus our analysis on the explanations listed above, we are able to see more clearly a complex pattern of contradictions in the factors formed in national culture outside the discipline of physics. In some countries girls' schools seem to be the solution, whereas in others countries access criteria may be the answer and in a third scholars point to physics as a compulsory school subject for both boys and girls. Similarly, the extended family appears to be the solution while others point to better day-care systems. Furthermore, we find that the countries which are known for a high degree of gender equality and women's emancipation are also the countries where most female physicists leave their career as scientists when they become mothers. Only two factors seem to be consistent: i) a disproportionate leakage of women from scientific careers at every stage in the academic hierarchy in the European countries and ii) the extent of the leakage differs from country to country. The *leaking pipeline* and the *glass ceiling* are descriptive metaphors which allude to problems within physics *as* culture. Neither of these problems has ever been explained in detail just as it has never been explained why pipes leak more in some countries compared to others or why some physics environments are more high-ceilinged than others. As we have shown earlier, we find no clear unequivocal explanation to the differences in numbers, if we confine our analysis to factors outside of physics.

As argued by Svinth (2008), we might leave the notion of the *leaking pipeline* altogether and turn to a discussion of what motivates women to leave academia. The same argument could be used in relation to the *glass ceiling*, which does not only represent limitations to women's career advancements but also the range of annoyances in everyday work life that motivate women to omit (often) well-

established careers in physics. The national reports discuss this issue extensively and describe a number of reasons in the everyday life in academia that motivate (women) to leave. To find out whether the physics activity as an isolated unit holds the key to our puzzle, we studied statements extracted from ATLAS.ti stripped of references to nationality, gender and stayer-leaver status. This also allowed us to disregard (for the analytical purpose) the immense national cultural diversity that characterizes our data material even though the five UPGEM countries share a range of cultural historical processes. As a result of this approach, we were able to identify patterns of contrasting clusters of cultural models, which we have described as the three ideal type scientific cultures. We find that gender carries different meaning in these scientific cultures.

7.2 Cultural diversity within physics *as* culture

In order to illustrate how the clusters of cultural models in the scientific cultures ascribe different meaning to gender, we will focus on the issue of femininity (and sexuality) and motherhood as examples of the relationship between gender and the selection mechanisms in the physics activity. It would have been possible to bring in findings regarding fatherhood and (new) masculinities, yet as the representation of women is the key issue in the project design, we have not included the latter aspects in this part of the analysis.

When looking for connections associated with femininity and (some form of) sexuality we find rather diverging patters within physics *as* culture; one of the scientific cultures femininity is typically connected with sexuality and is perceived to be incompatible with the physics activity. In the other two, femininity (and some form of sexuality) is not perceived as incompatible with the scientific activity. Of the three scientific cultures, the Hercules culture is the one in which we find the most aggressive relation between male and female scientists. Here, we have found that when women are thought of as sexually available they are connected to a low estimation of their qualifications as researchers (see also Hasse 2002). Furthermore, nothing (but devotion for scientific

development) is sacred and anything can be used in the competition that permeates Herculean workplaces. The ideal way of acting is thus constantly to evaluate whether certain actions will strengthen or weaken one's position in the competition. Therefore, sexual harassment is more outspread in the Hercules culture than any of the two other scientific cultures, because it can be used as a way to overcome a competitor. Consequently, our analyses show that sexual harassment can be "a contributory reason for leaving" (Hasse, Sinding and Trentemøller 2008b, 120) just as "femininity is an attribute to be overcome" (Vainio 2008, 245).

Whether either, or both femininity and sexuality can be used as an element in competition in the Caretaker culture largely depends on the group. Just as a Caretaker group may decided to turn against an (in the eyes of the group) inappropriate/d other (Trinh Minhha op.cit. Haraway 1992, 299), a Caretaker group could decide that femininity does not fit the group dynamic and consequently the physics activity. However, it is more conceivable that femininity and lack of scientific qualifications are not connected in a Caretaker group. As discussed in Chapter 5, the Caretaker culture builds on the notion of the whole person (i.e. an integration of the private and public sphere), which (on the part of the women) includes being either, or both womanly and motherly in the physics activity. Thus, rather than being an element that can be used to weaken women's positions, we have found examples of women who find that their femininity may even strengthen their position in the group; in a Caretaker culture that means strengthening one's position in the physics activity. Consequently, comments concerning a woman's appearance are not necessarily perceived as discriminatory.

One might expect sexual harassment to be a problem in a Worker Bee culture since the group leaders in this type of scientific culture are typically Herculean physicists who believe they can use (or misuse) anybody (e.g. women) and anything (their power). Nevertheless, the overall characteristic of the Worker Bee culture which is a clear demarcation between the public and private spheres seems to have the effect that connecting employees or colleagues with elements (e.g. femininity and sexuality, but also family, children and hobbies) belonging to the sphere outside the professional physics activity is very rare.

The clear demarcation between private and public in the Worker Bee culture also entails that motherhood is not integrated in the workplace culture. Moreover, because Worker Bee physicists (regardless of parental status) find it important to match the number of hours at work with their contract and salary, motherhood *per se* is not connected with either inclusion or exclusion mechanisms. On the one hand, Worker Bees find it relatively easy to move from one task to another within the broader physics activity (remaining stayers) or outside the activity (becoming leavers). On the other hand, the Worker Bee culture is characteristic of a very formal hierarchy, which may entail that fear of letting the private sphere impact on the public sphere. Maternity leave, for example, can be problematic for the woman because she may be fear the leader's reaction to her 'letting' the private sphere intervene with the public sphere in the sense that a maternity leave equals absence from work.

In the Caretaker culture, being on leave can be risky, as one is away from the group so the social ties with the group are in danger of being loosened. Yet, because the Caretakers integrate the public and private sphere by, for example, planning activities for colleagues and their family members and are attentive to each other's well-being, the group tends to show understanding of the obligations following motherhood (and fatherhood). Moreover, the parents tend to find ways to mitigate the problem of a leave of absence by working from at home or work flexitime bringing children and possibly as babysitter or grandparent with them.

Connection of parenthood and devotion to physics is not considered possible in the Hercules culture, because it is seen as taking time away from the only important activity – the physics research. Thus, women (and men) expressing a wish for children or spending more time with their family will be marginalized in the activity. Moreover, to prioritise time with family over physics will be perceived as an indication of lacking devotion to the physics activity.

In summing up our brief outline of the emic meaning (i.e. the informants' understanding of the meaning behind the words) of gender in the scientific cultures, we return to Figure VI (which was first presented in Chapter 4). As mentioned previously, in this discussion we

will focus on attitudes to women in physics because that is the key issue in the project design. The last row of Figure VI lists the meaning ascribed to gender in each of the three ideal types.

Figure VI *Directive force in the three ideal type scientific cultures*

Cultural models:	**HERCULES**	**CARETAKERS**	**WORKER BEES**
Work relation	Physics is the only thing	Physics is everything but must be socially acceptable	Physics is not everything in their life
Workplace Identity	Focus is on ego	Focus is on the group	Focus is on the task and family and friends
Competition	1-on-1 fights using all means available	Group versus group	Uninterested in competition
Power relations	Anti-authoritarian with hidden power games	The group requires young members work their way up	Formal hierarchy
Gender in the cultural models:	**HERCULES**	**CARETAKERS**	**WORKER BEES**
Gender	Used as a negative element e.g. in competition	Acceptance of gender roles in relation to groups and not used negatively e.g. in competition	Not used negatively in e.g. competition

As mentioned in Chapter 4, the Herculean culture is not exclusively a male culture, and our data material holds examples of statements from women who in these statements show characteristics of the prototypical Hercules physicist. They are female physicists who are fully devoted to their science, who wants to be in power and who are willing to compete with all means. Though we find signs of female Hercules physicists, we have typically referred to Hercules as a man, because we find more statements by men, who deliver material to the clusters of cultural

models generating the Hercules culture. By looking at the clusters of cultural models within the ideal type cultures we do not find any explanation as to why femininity and not masculinity can be an element that weakens one's position in competition, and why the male physicists appear to be the ones who set the agenda in the Hercules culture.

The ideal Caretaker culture encompasses both the masculine and feminine characteristics of its members and is thus less gender biased. In this context, gender may play a less determining role. As a result it resembles to some extent the Worker Bee culture where gender plays an almost non-existent role for work in spite of clear societal gender roles.

In the Worker Bee culture competition is not a permeating characteristic nor is everything perceived as possible elements in competition. Because Worker Bees do not orient themselves towards the group, the other colleagues do not determine what can be used in competition – as is the case in a Caretaker group. At a Worker Bee workplace the benchmark is diligence, and regardless of gender, anyone can count as a diligent physicist. Moreover, with the right title (and associated power) anyone should be able to take up a top position irrespective of gender.

On this basis, we might assume to find the most women in Caretaker and Worker Bee cultures. Is this the case when we look at our empirical data? In order to answer this question we investigated the relation between our definition of the ideal scientific cultures and the nationally embedded physics activities. This is in part done by correlating the patchwork of life stories with our categories of nationality and gender. In other words, we have tried to combine the physicists' description of physics *as* culture with findings from physics *in* culture.

7.3 Combining method, theory and findings within physics *in* and *as* culture

As researchers we decide, to which type of learning, we ascribe the most importance; e.g. learning as a physicist among other physicists globally or learning as a Danish, Italian, Polish, Estonian or Finnish physicist in our respective national context. We may appear to have

placed more importance on the national context since we initially drew our analytical lines along the national borders in the project rather than initially analysing the workings of the physics culture across the national borders. Yet, by contrasting our findings from the national contexts we have sought to identify implicit comparisons (see Chapter 2) in the informants and ourselves as researchers. We have used these as an entry into studies of the motives directing actions within the physics activity. In that respect, we come to place equal weight on physics *in* culture (the five national cultures Denmark, Finland, Italy, Estonia and Poland) and physics *as* culture (i.e. the three ideal scientific cultures Hercules, Caretakers and Worker Bees).

As researchers we also decided to make the elicitation of our implicit comparisons one of the research aims in the project. For this to succeed, a close collaboration building on mutual respect is crucial. In the case of the UPGEM project, partners and assistants have shown continuous willingness to be challenged (though it at times can be demanding) and to challenge assumptions and so learn to think in new ways. Thus, if we look at UPGEM as an activity system of research with the object of producing a common product, we can say that the group has indeed expanded as a community of learners and researchers in practical activity. Furthermore, given the relatively brief time we have spent together 'face-to-face' and given the instability of short term contracts typical for projects like UPGEM, the group has expanded a lot.[32] In this dynamic process we have also challenged the theoretical concepts and meanings of our own *a priori* categories and questioned how activities and cultures are related. We have been inspired by our discussions of the informants' life story statements to gradually transform the analytical tool of activity[33] to include the notion of culture contrast. This method follows the theory of cultural learning

[32] It should be noted that compared to many international projects, we have spent more time together than normally and we have stressed the social aspects of group work during all our seminars. This has been a deliberate choice because we have worked to obtain a common object of the research and we find that these social aspects combined with our interest in each other's work have strengthened the high quality of work delivered by the research assistants.

[33] Also discussed by Hasse, Sinding and Trentemøller (2008b, 26–27)

processes (Hasse 2002; 2008) through which national cultures and cultural models (in physics) may be contrasted. Through the theoretical intersection of the concept of activity and culture we began to understand our own research and analysis as moving towards an increasingly shared framework for interpretation.

In the following example of incidences of and attitudes to sexual harassment among our physicists (and to some extent among us as researchers) we illustrate the interplay of national cultural historically informed differences and the directive force inherent in each of the ideal type cultures. Drawing on a former study by Hasse (2002), we found it relevant to include 'sexual harassment' as one of the etic categories (i.e. the general research categories informed by academic theories) in the project design. Consequently, a question about experiences of sexual harassment was included in our interview guide. From the physicists' statements and on the basis of the results presented in the national reports[34], we can deduce that sexual harassment can occur at any of the studied universities as workplaces in the UPGEM countries. Yet, as mentioned above, we also find that a number of factors concerning this category differ depending on the national context. In fact, one of the differences showed itself in the method used by the research assistants when asking about sexual harassment.

In spite of the process of formulating the question collectively at the Innovation Seminar in Copenhagen, the actual asking was conducted in very different ways in the interviews in the respective partner countries. In the following, we will argue that these variations in method are more likely to be due to cultural historically formed understandings of the connection of workplace and sexuality (shared between the research assistants and their fellow national informants) than due to any lack of a shared understanding in the project. The question on sexual harassment was phrased in English as follows: *Would you be surprised if any of your colleagues ever mentioned sexual harassment or other kinds of harassment as a problem at the workplace?* (see Appendix B in *Draw the Line!* (Hasse, Sinding and Trentemøller 2008a, 377))

[34] See *Full Collection of National Reports*

When contrasting the data material nationally it is clear that the Danish informants are rarely puzzled by the question and relate explicitly to cases of sexual harassment – as for example a direct offer of exchanging extra tuition for sex (Hasse, Sinding and Trentemøller 2008b, 83). This indicates some degree of expected prototypical pattern of conduct connected to the (accounted) episodes. In Poland and Estonia, the question elicited fewer narratives about sexual harassment (though stories of bullying were told). This may be because the researchers rarely probed further for answers. Yet, the transcripts show that in both countries a number of informants do not understand or relate to the question and attempts to probe deeper into the question do not elicit narratives of sexual harassment in these national contexts. In the Estonian context, further enquiry even provoked astonished laughter. In Poland and Estonia it can be much more taboo to speak of sexual harassment in front of an outsider like the researcher. We also know from the UPGEM seminars that even posing the question can feel much more awkward in Poland and Estonia than in Denmark and Italy. We would have had to conduct more research with the specific aim of probing into this subject to know exactly what is at stake[35]. Nevertheless, the Polish and Estonian (and to some extent also the Finnish) data on this matter certainly seems to stand in contrast to the Danish cultural historically formed context in which narratives of acts of sexual harassment that debase women are more frequent.[36] Thus by contrasting the propositions of statements, we find that the phrase sexual harassment seems to be understood differently in the Danish compared to the Estonian context. On this background, we view sexual harassment as a concept with a semantic content that calls forth different associations and which thus carries different national emic connotations. These associations and connotations may be shared by local informants and researchers and in that

[35] Researching an issue like sexual harassment is a very sensitive matter. Informants, researchers as well as the readers might interpret the statements in this report very differently, as this topic is likely to provoke strongly felt attitudes and opinions.

[36] It has been suggested that the Danish connotation within physics between women and sex is indirectly connected to the fierce women's liberation movement in Denmark (Hasse 2008).

case they are more likely to be identified when contrasted with the work of researchers from other national contexts.

Through the method of culture contrast we have explored and problematized the assumption that we, as researchers, can immediately decode the meaning of our informants' life stories, i.e. that we immediately understand the level of emic categories in the studied local physics activities. The tension between the cultural context and the language based interaction in the interview situations exemplifies the relationship between emic categories (i.e. the informants' understanding of the meaning behind the words) and etic categories (i.e. the general research categories informed by academic theories).

When we contrast the Danish and the Italian narratives concerning sexual harassment we find that though the Italians can also relate to the questions, the Danish physicists still seem to have ascribed different connotative meaning to the phrase. Moreover, different thresholds for when an act is considered sexual harassment seem to exist in the Italian and Danish data. In the Italian context, direct compliments from male researchers to female researchers seems to be part of everyday practice, and the men as well as the women rarely perceived these compliments as discriminatory or bordering on sexual harassment against women (Ajello, Belardi and Calafiore 2008, 313).

> Interviewer: *Do you think that your career would have changed if you had been a man?*
> Maria[37]: *Honestly, I have to say that when a committee to guarantee the same possibilities to men and women was created also here in this institution, many female colleagues came to me and asked me "when do you begin?/when do you travel abroad?", but I think I have never been discriminated, on the contrary I had some advantages because in a surrounding where they are all men, there is always some kind of pleasure in being kind to a woman, in giving her a bonus, in making her a favour. So there was no discrimination towards me. I remember that I had a female university [friend] who*

[37] Due to concern for anonymity we do not list the P-numbers etc. but employ fictitious names instead.

> *always opened a button more in her blouse when she [sat] for an exam and she used to say: "Look, this is a point more that I get", it is not always like this but sometimes you can – in a surrounding where there are a lot of men, there are advantages for a woman, but there can also be some disadvantages.*

In comparison with most of the Danish female physicists, the Italian female physicists are not afraid play on their femininity. In exceptional cases as the one above, they can even allude to themselves as sexual beings. This would be unthinkable in a Danish context because it is perceived as triggering a sexualisation of the body, which in the Danish context is connected with lack of scientific abilities (Hasse 2002, 286ff); as it is described by a Danish female physicist:

> Zindy: *(...) but there is something – I mean – I have – what I find hard is – when you travel to conferences and – what becomes difficult is actually eh – that you sort of get seen.*
> Interviewer: *As a woman?*
> Zindy: *Yes. I mean, you get – it is like you have a flashlight in your forehead [laughs]. I mean, (...) sometimes it is very demanding (...) and you talk to them [the men] and they talk to you just because you are a woman (...). And when you talk to them then they think you are interested just because you talk to them [laughs].*
> Interviewer: *Yes*
> Zindy: *And that can be really hard.*

We find that though the Danish and Italian physicists (men and women) may have had more experience building meaning into the term sexual harassment (either through personal experience or public discourse) than the Polish and Estonian physicists seemingly have, the emic meaning connection to the term in the local workplace activity differs in the Italian and Danish context. Consequently concepts like woman, sexuality and scientific work come to carry different meanings in the national contexts.

When this finding was brought up and contrasted at the UPGEM seminar it challenged hitherto unchallenged self-evident understandings and led researchers to probe into deeper analytical levels of their

national material. One of the connotative meanings formed in practice in the Italian context is the notion of 'drawing the line', which, as the Italian UPGEM researchers describe, implies the notion of responsibility on part of the victim. Some of the Italian "interviewees think that the victim is somehow guilty and responsible when sexual harassment takes place (…). It is even more interesting for us to note that only women raised this matter" (Ajello, Belardi and Calafiore 2008, 314). In the Danish physics activity is the notion that the woman must 'draw the line' is also present. But in this context it does not entail an element of responsibility, rather it is explained by the fact that "man may have this flaw that he cannot control" (Hasse, Sinding and Trentemøller 2008b, 86). This conclusion is based on several narratives, where 'drawing the line' is expressed more or less explicitly as a self-evident precaution for the Danish female informants (ibid.).

Is sexual harassment therefore a particular Danish problem? Here we have to remember that the lines of analysis are set by the researchers – other lines could have been drawn if the research had been conducted differently (for example differences between connections drawn in physics as culture versus biology as culture). By using culture contrast as method, new self-evident connections are called forth, which may otherwise not have been noticed by the researchers.

7.4 Combining gender in the scientific cultures with national cultural historical processes

To better understand how the interrelation of national cultural historical processes and scientific cultures influences the diverging representation of women in physics, we will discuss three cases exemplifying the embodiment of the ideal type scientific cultures in national cultures. In other words, we will attempt to combine our level of abstraction (the ideal types) with the tangible life stories (the empirical data). When we relate the physicists' statements with their nationality, a pattern of inclination towards one ideal type scientific culture in some countries and another in other countries also emerges.

In line with the analysis presented in this publication, the glass ceiling can be understood as cultural models which are formed in national culture and connected with clusters of cultural model in physics as culture. These clusters can impede women from advancing in their careers and thereby form what is referred to as glass ceilings. Depending on whether nationally formed cultural models merge with one or the other of the ideal type cultures, the glass ceiling can 'hang higher or lower'.

On the basis of the culture contrast analysis, we must conclude that physics departments that are affected by Caretaker characteristics in physics *as* culture as well as physics *in* culture we can expect to find a higher representation of female physicists. We find that men with Caretaker characteristics also thrive in Caretaker cultures.

As mentioned, we have found Caretakers, Worker Bees and Hercules types in all UPGEM countries, but we have also found inclinations towards either of the ideal type cultures in the UPGEM countries. In the case of Denmark we seem to find a pattern indicating an inclination towards a predominantly Herculean culture (54 out of the 73 statements in Chapter 4 were delivered by Danes). In Italy we find an inclination towards the Caretaker culture (61 out of the 89 statements in Chapter 5 came from Italians). In Estonia and Poland we have found, with a particular reference to the past, inclinations towards the Worker Bee culture (In all, the Estonian and Polish informants deliver 72 out of the 86 statements in Chapter 6). Finland seems to have a more mixed culture and no clear pattern has appeared in our analysis. It is important to note, that none of the UPGEM countries is exempt of either of the ideal type cultures.

Just as there is not a one-to-one ratio between our informants and the ideal type physicists there is no one-to-one ratio between one of the UPGEM countries and one of the ideal type scientific cultures. An informant can, for example, express both Caretaker and Hercules characteristics during an interview, and physics institutes in one national context can have a number of characteristics from all three scientific cultures. It is always a matter of a mixture; but, in some cases, we can identify patterns that indicate an emphasis of one of the ideal types which in turn affects the degree of gendered career path in the local physics activity. In our description of these patterns we return to

the examples presented above. Once again we begin by focusing on the differences between Denmark and Italy, which also illustrate inclinations toward the Hercules culture versus the Caretaker culture. Subsequently, we present an inclination toward the Worker Bee culture based on examples from the Estonian material (and to some degree the Polish). The last UPGEM country seems to constitute an interesting constellation which may need further investigation. It appears that Finland has a more gender segregated workplace compared to the other UPGEM countries in the sense that the male stayers tend to compete like Herculean physicists as they report a number of incidences of power plays, intrigues and communication problems in the interviews (Vainio 2008, 242). The female stayers as well as leavers, however, seem to place emphasis on Caretaker and Worker Bee characteristics.

Not all cultural models in the scientific cultures seem to be equally relevant to the question of women in physics and we shall therefore only refer to those we do find relevant. Though we have not in a systematic manner addressed the question of quota in our research work (it was not part of our interview guide), we have found statements from our informants relating to this topic. Therefore, we assume this issue is of interest and importance to some of our informants – who typically cluster in one of the scientific cultures.

To give an example, Hercules types will react against quota because they believe everything in the physics activity can be used in competition. Therefore they will react strongly against any advantages given openly to a defined group of physicists – as for example quotas or other types of affirmative actions favouring specific groups, e.g. women. If women enter the physics activity on the basis of quotas they will be mocked as less qualified physicists. It may seem as a paradox that physicists who are given positions through affirmative actions can be labelled 'not qualified' while Hercules types who happily obtain positions through contacts are accepted as qualified. To earn positions or status through nepotistic networks requires some degree of active effort. Affirmative actions, however, are perceived as a passive way of receiving one's position. It is a reward system outside of competition and therefore Hercules physicists will automatically have negative views about it as it leaves them no chance of competing against the

'favoured' person or group. In the Hercules culture, affirmative actions are perceived as the opposite of survival of the fittest, and the outcome must consequently be poor. This is typically the kind of statements we find in the Danish material, where quotas have been a hotly debated issue. In other UPGEM countries quota is not an issue at all or not seen as a potentially problematic issue.

In the Worker Bee culture, Worker Bees would find it unfair if anything but work efforts occasioned a promotion. Yet, if the order came from above, it would be accepted. Gender is considered unimportant, thus the Hercules leaders would not support affirmative action, because they would only reward hard work and would see no reason to promote female scientists especially. We have found a few statements among the Danish and Estonian physicists which we can connect to this attitude.

What is important to note here is that when we look to our empirical data we might find, that gender *does* matter in a Worker Bee culture (men and women are in reality not on an equal footing), but the informants do not make these connections between gender and inequality themselves.

In the Caretaker culture, the attitude to favouring a specific group of physicists – either because of gender or because they constitute a marginalised group in the physics activity, will only be problematic if the favoured person is not one who has been already chosen by the group. The notion that the best qualified is only found in fierce competition does not apply to this culture, wherefore neither the gender nor other 'specific characteristics' of the favoured person could be perceived as a possible 'mocking' element. The group might react negatively to decisions made outside the group, if they establish a demarcation between the group members. However, we have no such concrete examples in our data material, probably because few UPGEM countries have discussed this issue.

In the following we will illustrate the embodiment of the scientific cultures in national cultures.

7.4.1 Hercules culture in Danish national culture

As described above (and in the national reports) we find the most direct cases of sexual harassment of women occurring in Denmark, which we have found to be one of the more indirect reasons a substantial number of the female stayers plan to leave physics (Hasse, Sinding and Trentemøller 2008b, 123). As previously argued, being seen as a woman often implies being perceived as a sexual object, which excludes being perceived as a good physicist. Thus, we find that gender can be used as an element to overshadow the women's skills as physicists in competitive situations.

The predominant scientific culture at the studied Danish physics institutes supports individual, brilliant and forceful physicists, even though they may use means like tacit gender discrimination to get ahead in the competition. Furthermore, we find that many stayers and leavers who complain about the very politically controlled environment with a system building on individual competition for positions (up to the level of associate professor there is no secure tenure track). Thus, in the studied workplace cultures in Denmark, we find a fierce competition for positions, funding and recognition of research results between individual researchers. The prototypical way of winning this competition is by showing deep devotion to physics, which includes working late at night, being prepared to travel abroad at any time and in general devote oneself to the local and the international environment of physics. Yet, personal networks and slander are also used when the Danish physicists compete to make Nobel Prize winning physics (see description of hidden competition by Hasse, Sinding and Trentemøller (ibid., 77–80).

Young physicists are chosen by old Hercules types looking for new protégées and potential Nobel Prize winners – for which a man is perceived to be the better candidate. Women can enter this culture, but their sex makes them stand out as less qualified because they tend to be associated with issues (sexuality and children) that are excluded from the physics activity. On a more positive note, this culture seem to get hold of very dedicated physicists and many of the Danish physicists

convey a strong love or passion for physics in their interviews (ibid., 64).

Unfortunately, the notion of devotion, which to some extent is measured in hours at the workplace, scares many of the family-oriented physicists away. If we return to Figure III Gender of stayer and leaver parent physicists in UPGEM countries (Chapter 3), we see that Denmark has the highest percentage of mother leavers. Moreover, in the Danish material we have found indications of men, who wish to share the responsibility for the family or integrate work and family (we have referred to these as new masculinities) and a good part of these men are also leavers. The clash between new masculinities and Herculean work-place culture that is hostile to children has been reported both in Chapter 3 and in *Draw the Line!* (ibid., 107, 118–119 and 124).

Placing the findings from the Danish context together, we find that the many of the attitudes and actions of the Danish informants are either reactions to, or motivated by, the cultural models we find in the Herculean culture. These cultural models influence the perception of the female physicists as mothers and elements to be defeated in competition. We find Worker Bee and Caretaker tendencies in the Danish culture, but they are placed in a predominately Herculean culture, which often leads to frustration and thoughts of leaving physics.

7.4.2 Caretaker culture in Italian national culture

We find the Italian physics activity to be primarily characteristic of the Caretaker culture because the physicists are very attentive to the social relations in conducting physics research.

Looking closer at the Italian data, we find that even though women are also in competition with their male colleagues here they might be perceived in another way as women. Indeed in comparison to the Danish (predominantly Herculean) culture, femininity is not perceived as overshadowing or excluding skills in this context. Part of the reason is to be found in the Italian physicists' description of the organisation of work and competition in Italy.

Discussion and Conclusion

We find that the Italian physics culture is largely organised in groups and that these groups often constitute small baronies (Ajello, Belardi and Calafiore 2008, 282) or little kingdoms that are structured like patriarchal family networks. Women are generally respected members of these family-like networks at the workplace, but they rarely reach top positions. The head of a group should preferably be powerful, but they are always expected to take care of the group. This also means that the Italian Caretaker leader is responsible for securing jobs for the next generation. Young physicists are, however, "expected 'to rise through the ranks" (ibid., 283) before they earn this favour (in the form of a permanent position) by working, sometimes for free, for the local baron (typically a professor). This makes the physicists very aware of the social relations and ties with their group, which means that competition is not so much for individual prestige as for prestige to the group. In other words, a physicist in a Caretaker culture is not allowed to disregard social relations and social obligations – even if it means choosing a friend or family member over a better qualified physicist (ibid., 304). The Italian data holds examples of physicists with Herculean characteristics, but a 'pure' Hercules type would be kept in check and balance by the social obligations that characterize the environment.

From the analysis of our data material it is clear that the Italian female physicists are strongly connected with motherhood and that motherhood is expected and therefore not a reason to exclude women from the physics activity. As we have shown in Figure III, the highest percentage of mother stayers is found among the Italian informants, even though the Italian birth rate is known to be low. To some extent, the connection of woman and motherhood is so strong that being a mother brings some degree of status at the workplace.

Italian female physicists can take up a position as 'family-members' in a group, so that they can (irrespective of gender) be rewarded by the local baron. It may be more difficult for women to become local 'baroness', but they can obtain a top level position if the family-like power structure of the group allows it. In that sense, the 'academic family' carries more weight than gender. This is also supported by our findings relating to the extended family and the role of family background in Italy in general.

7.4.3 Worker Bee culture in Estonian national culture

As noted by Endla Lõhkivi (2008) many of the Estonian informants describe "their everyday work during the Soviet period as having *Worker Bee characteristics"* (ibid., 96). On the basis of the interviews she notes that "[s]trong charismatic leaders of the Herculean type were admired and endorsed" and they "were responsible for really large institutes and a variety of research themes. They were free to make managerial decisions" (ibid., 96).

The Worker Bee physicists in the Estonian (and to some extent the Polish) data do not describe competition as fierce, because it typically took place at institute level rather than group level. The workplace structure at the Estonian physics institutes was very hierarchical and the physicists' relation to their institute leaders was characteristic of being like a worker – boss relationship with no social interaction. In that sense the demarcation of the private and public sphere was very clear. Contrary to our analysis of the Italian predominantly Caretaker culture, we find that the Estonian leaders did not feel obliged to take care of the next generation. Some narratives describe how the 'old guys' (i.e. Herculean leader) have deliberately tried to keep young male competitors away from their institute to avoid competition and ensure higher personal salaries.

As in the case of the Worker Bee culture, the central aspect of work for the average physicist was not to conduct Nobel Prize winning research, but to do well through work under decent conditions. Therefore, the heroic image of "the priest of truth" (who bears some resemblance to the Hercules type) often gave rise "to certain expectations that the everyday life of a physicists cannot live up to" (Velbaum, Lõhkivi and Tina 2008, 173). Consequently, we find critique of the culture in which "loss of interest" and "frustration" (ibid., 173) are not uncommon because the physicists were not rewarded or noticed in the system by the leaders.

Local physics environments in Estonia have clearly suffered a severe blow in 1989. During the Soviet occupation, most physics research in Estonia was financed by the Soviet Union, but after the fall of the Soviet regime, the very dominant institute leaders saw their power erode along with their former relations to Soviet Ministries. Today a new and "more democratic and transparent" structure has been developed (Lõhkivi 2008,

96). The individual researcher must assume more "initiative, responsibility and entrepreneurship" (ibid., 96) and compete for funding in new ways; largely through international competition.

Most of the young generation of males has left for better options abroad or in industry. In some respect, the break with the predominantly Worker Bee culture still seems to be in process, as some leaders appear to hold on to their power through attempts at upholding the formal hierarchy. In this context the young female physicists typically take up the role of Worker Bee physicists, possibly because they have not been offered better job possibilities.

The representation of women might have been higher during communism (as it was in the Soviet Union) than it is today, but we have found little official statistics on this issue[38]. The aspect of women's femininity and sexuality are seen as belonging to the private sphere and therefore not connected with their position as workers. Women can be perceived to be good, diligent physicists, but they are rarely thought of as potential top leaders – neither in the old nor in the new system. They might ask for higher salaries and better work plans of their male leaders, but not more power.

7.5 Conclusion, shortcomings and perspectives

We have found that local cultural historical learning processes have formed cultural models, which make the connection between women and physics more self-evident in some UPGEM countries compared to others. We have also shown that the clusters of cultural models in physics *as* culture can form a frame for the selection mechanisms that determine the inclusion and exclusion of female (and/or male) physicists. Moreover, we have tried to connect the nationally formed cultural models with the identified patterns of selection mechanisms in the individual UPGEM countries and in so doing embedded the predominant characteristics of one of the scientific cultures in the national context. When cultural models formed in national cultures are

[38] See Appendix I

combined with the clusters of cultural models in the scientific cultures they are connected in new ways. There appears, as a result, some kind of mutual reinforcement between the cultural models formed in the national cultures and the clustering of cultural models formed in the scientific cultures.

As mentioned, Finland seems to be less unequivocal regarding emphasis on one of the scientific cultures over the other. With respect to Estonia and Poland, we have found that the power structures of the Soviet period rested on a formal hierarchy which resembles the power structure we have identified in the transforming Worker Bee cultures in these two countries, but which seem to have affect women differently. We have also found that the classical physicist, which rests on openness between the discipline of physics and philosophical and societal concerns fits well with the extended family and the Caretaker culture, primarily found in the Italian data. In Denmark, a societal interest discussing gender related issues (possibly emanating from negotiations in the nuclear family) seems to translate into the Herculean cultural models and form subtle battlefields between the male and female scientists. Thus, we have to some extent come closer to an answer to why we find more women in the Southern and Eastern parts of Europe.

Though the culturally different patterns of connections are analytical constructs, we argue that our analysis contributes to the understanding of the processes behind inclusion or exclusion of women from physics and thereby contributes to a better understanding of the nature of the somewhat mysterious and metaphorical *glass ceiling*. In addition, we see a possibility of further exploring our approach in relation to three perspectives in our material which would be interesting to unfold in future research:

A. Contrasting with others European countries (Appendix I)
B. Endogamic couples (Appendix II)
C. Diversity in male and female physicists' field of interest (Annex V in *Draw the Line! International Conference, Copenhagen 2008*)[39]

[39] Annex V is presented in Hasse, Trentemøller and Sinding (Eds.) (2008c, 150).

For future research, our tentative examination of these perspectives is presented in Appendix I–II and Annex V. Firstly, we believe that with more time and resources the research could have benefited from an even wider inclusion of countries, such as the ones briefly outlined in Appendix I. By including countries like Portugal and Hungary, where the representation of female physicists is relatively high, in our culture contrast analysis we might find new connections (and complexities) which could lead to a more refined model of analysis. Secondly, we have found a consistent pattern of female physicists being married to male physicists, but we have not found any clear relation between endogamic couples and scientific culture nor a relationship to the stayer/leaver problem (Appendix II). Thirdly, within the frame of physics *as* culture, we have also found that women tend to cluster in particular fields of physics (see for example Vainio 2008, 238-240). We found an almost absence of women in theoretical physics but a high concentration in geophysics. These findings have not been examined in relation to our model of analysis, but they point to the need for a more fine-grained analysis of physics *as* culture (see figures in Annex V).

For future research it would also be beneficial to further investigate the extent to which the mechanisms from physics *in* culture and physics *as* culture interact. This question also concerns the very notion of the role of universities in a knowledge society which is discussed in the network of Social Studies of Science and Science and Technology Studies in general. We see many possible connections between the discussions of 'Science as Culture' (Traweek 1988; Reid and Traweek 2000), 'epistemic cultures' (Knorr-Cetina 1999), 'ANT' (Latour 1987; 1993) and the discussions of Mode I and Mode II. Yet, partly due to our analytical frame (i.e. our combination of culture contrast, activity theory and theory of cultural models) we have been unable to unfold and integrate these studies in our project.

As for the theoretical aspects, we would have liked to further explore the theoretical perspectives of our model of analysis. We draw on activity theory and theory of cultural models but our conflation of the two has not been dealt with in detail. We assume that what can be analysed as cultural models are formed in activity systems as are objects and artefacts. Moreover, we assume that, like the tools and instruments used

in activity, these models have cultural histories, which are transformed into new meaning when they are put to use in particular activities.

We have also not discussed in what way our model of analysis addresses or challenges mainstream gender theory – e.g. theories of sexual difference or gender theories of performativity (Braidotti 2002; Butler 1993). We do se a number of possible connection points with some aspects of these theoretical frameworks, but in one respect our approach differs greatly from the approaches most frequently used in gender studies. Where many gender studies focus on gender as the *a priori* guideline for their analysis, we have chosen to focus on cultural models first and gender secondly; that is gender is only included as an element in our analysis if it is entangled in cultural models. In some ways, this method is a new approach to studies of gender and must be further explored empirically as well as theoretically in the future.

We would like to end our analysis on a more speculative note, by drawing up a possible correlation of class and gender in society with the representation of women in physics. In the introductory chapter, we saw that the most industrialised countries have the lowest percentage of female staff. Can our framework explain why this is so?

From a theoretical point of view the long list of explanations could be perceived as a list of cultural models relating in different ways to gender and formed in national cultural histories. We could speak of different cultural models for education and science, where some national cultures connect particular types of science and education with gender. This would be the case in Denmark, where we find tendencies toward gender segregated school education and university education; physics is for men and women study humanities which excludes a career in physics. We could call such a society a ‘Gender Society’.

We could also talk of different cultural models for labour, where domestic chores and caretaker tasks are traditionally connected with the woman in the private (domestic) sphere and not the public sphere. We could call such a society a ‘Class Society’.

In a Class Society the traditional gender roles prescribe the women the responsibility for household chores and children. In Catholic countries the woman has traditionally been ascribed the role of a Madonna with a child, who is worshipped and valued. From this

perspective we can say that the class society also builds on traditional values of the 'blessed' woman and the 'blessed' family with the patriarchal father. Yet, because of the central role of the woman in the domestic sphere, she can stand by her husband's side as his equal; this is possible because of the gendered demarcation between private and public activities. Analytically speaking, their activities belong to two different spheres – the private and the public. In this context, public refers to the non-domestic sphere where the men are working (Public I) and private refers to the domestic sphere where the women are working (Private I). As women and men are ascribed clearly different gender roles by the cultural models formed in activities, they do not have to negotiate or in a more extreme version, fight, each other.

When women from Private I begin to move into Public I they are initially not considered a threat by men, but a colleague who can work in all fields of Public I. In this context, the societal fight takes the form of a class struggle in the public sphere (Public I). One may wonder how women can enter the labour market if they hold the responsibility for the activities in Private I. In class societies it is widely accepted that women, who enter Public I, should be helped with their tasks in the Private I, either by the extended family or by employing nannies and housemaids. If they belong to the upper class or the upper middle class women can ask for and receive help or financial support to pay for nannies or servants from their family network (either or both parents and husband). If the women belong to the middle and lower middle class they will also receive help from their family, though not economic help. Women from this class will be more motivated to prove their worth in Public I (e.g. male dominated fields like physics) than upper class women because it can be a way for the lower class women to move up a class.

A contrast to the 'Class Society' is what we call a 'Gender Society' where (in spite of its name) the gendered demarcation of domestic and public spheres is blurred and gender roles traditionally and firmly connected to specific activities are dissolving. Thus, in a Gender Society, men and women are considered to be on par in relation to cultural models for activities in Public I and Private I, whereby gender is both reduced and accentuated. On the one hand, gender does not

serve to tie men and women to specific separate activities. On the other hand, women and men must negotiate who should be responsible for the household activities formerly managed by the woman (in Private I).

The notion that household chores and children principally are the responsibility of both man and woman (who can draw on a state funded system) is the predominant idea. However, in practice women still tend to hold the main responsibility. Because of the overall ideology of shared responsibility the family (typically grandparent) may not feel a particular obligation to help the woman, as it is expected that she negotiates and plans the division of activities in the domestic sphere (Private I) with her husband. In the Gender Society we find no worship of the 'blessed' mother.

An important point in relation to our discussion is that in the Gender Society, women and men must also negotiate about the activities in Public I, which was traditionally managed by men. In some cases, the ongoing negotiation turns into a fight between men and women as we saw in the case of the fierce women's liberation movement. Possibly to avoid fighting in the same professions in Public I, a new gendered demarcation in Public I has been generated and maintained. The new distinction between public and private is, on one side, the state funded public sphere (Public II) and on the other side private enterprises etc. (Private II). Thus, Private II is (in spite of its name) also found in the sphere of the traditional Public I. As a result we have a gender demarcation of specific types of educations relating to the activities in the public sphere. Women primarily chose to study humanistic subjects and work in Public II, while men tend to study science and engineering which enables them to work in Private II activities. The result is a gender segregated labour market and a gender segregated educational pattern (hence the name Gender Society).When the activities in Public II and Private II generate cultural models for competition, gender will be an epi-phenomenon in the sense that gender can be used in competition as a mechanism for inclusion or exclusion.

In the Class Society it may be easier for women to engage in all sectors of the labour market initially. Yet, the more women entering the labour market, the more blurred becomes the demarcation between

Public I and Public II, and a reaction will come about. In doing so, the Class Society gradually moves towards a Gender Society.

In our empirical data, the patterns of a Gender Society are primarily found in Denmark and to some extent Finland. Poland and Estonia are special cases in so far women under communism have been forced to manage both Public II and Public I as well as Private I. The patterns here are very complex, but Estonia seems to resemble Denmark and Finland the most. Poland (with the influence of religious cultural models) comes closer to the patterns found in the Italian data, where the (historical and to some degree current) demarcation between Private I and Public is relatively clear. This is very likely to be the case in Portugal and Spain too. The demarcation of the spheres could also explain why women in a Class Society face problems with the glass ceiling; though they can move freely into Public I, they cannot be detached from the activities in Private I as the cultural models connect them with children and household chores.

University as a workplace is like any other embedded in national cultural historical processes and if societal cultural models in a Gender Society generate gender specific interest in academic disciplines, we would expect the majority of the women are not attracted to 'male' disciplines and vice versa. In a Gender Society we might also find subtle conflicts between men and women for keeping each other out of their respective 'gendered' educational activities. In this context, physics could be seen as a male activity. In a Class Society fewer women would get a higher education (and in historically speaking an education at all as their activities were set in the domestic sphere – Private I), but those who do would not be directed in their choice of discipline by gender specific interests.

We assume all areas of academia as a workplace are affected by cluster of cultural model which form ideal types. Moreover, we can speculate that the Gender Society is rarely found within the Caretaker and Worker Bee cultures. Consequently, one may assume that the Gender Society will generate a Hercules culture. Yet, we speculate that the ongoing negotiation of gender roles in the Gender Society challenges the cultural models in the Herculean culture because women and men (i.e. men who represent new masculinities) will not accept having to choose between family or career.

Some of the issues we have taken up in this publication have been discussed from national perspectives in our publications *Draw the Line! Universities as workplaces for male and female researchers in Europe*, *Full Collection of National Reports* and *Draw the Line! International Conference, Copenhagen 2008. Proceedings, papers and recommendations*. It is the combination of all the work in UPGEM, which feed into the UPGEM recommendations presented and discussed in the latter of the three publications. Our main recommendation is to identify the selection mechanisms of the given scientific culture and secondly to break the cultural patterns these mechanisms form. By employing our definition of ideal type scientific cultures as a tool to identify the predominant cultural patterns directing actions in the given activity, we believe it is possible to break these patterns and thus dissolve the problem of gendered career paths.

Reference list

Ajello, A.M., Belardi, C. and Calafiore, G. (2008). UPGEM National Report Italy. In C. Hasse, A.B. Sinding and S. Trentemøller (Eds.). *Draw the Line! University as workplaces for male and female researchers in Europe* (pp. 263–366). Tartu: Tartu University Press.

Alper, J. (1993). The Pipeline is leaking women all the way along. In *Science 260*, 409–411

Aull Davies, C. (1999). *Reflexive Ethnography. A guide to researching selves and others.* London: Routledge.

Barinaga, M. (1994). Surprises Across the Cultural Divide. In *Science 263*, 1468–1472.

Bourdieu, P. (1977). Cultural reproduction and social reproduction. In J. Karabel and A.H. Halsey (Eds.). *Power and Ideology in Education* (pp. 487–511).New York: Oxford University Press.

Butler, J. (1990). *Gender Trouble. Feminism and the subversion of identity*. New York: Routledge.

Butler, J. (1993). *Bodies that Matter. On the discursive limits of "sex"*. New York: Routledge.

Butler, J. (2004). *Undoing Gender*. New York: Routledge.

Braidotti, R. (2002). *Metamorphoses. Towards a Feminist Theory of Becoming*. Cambridge (UK): Polity Press.

Callaway, H. (1995). Ethnography and experience. Gender implications in fieldwork and texts. In J. Okely and H. Callaway (Eds.). *Anthropology and Autobiography*, London: Routledge.

Carlson, B.A. (2000). Women in the Statistics Profession. In *International Statistical Review, 68(3),* 339–352.

Chodorow, N. (1978). *The Reproduction of Mothering. Psychoanalysis and the sociology of gender*. Berkeley: University of California Press.

Chudzicka-Dudzik, P., Diekmann, A., Miazek, M. and Oleksy, E. (2008). UPGEM National Report Poland. In *Full Collection of National Reports. Universities as workplaces for male and female researchers in Europe* (pp. 362–441). Retrieved August 14th at http://www.dpu.dk/Everest/Publications/Subsites/UPGEM/20080812161221/CurrentVersion/Full%20Collection%20of%20National%20Reports_b.pdf

Cole, M. (1996). *Cultural Psychology. A once and future discipline*. Massachusetts: The Belknap Press of Havard University Press.

Engeström, Y. (1987). *Learning by Expanding. An Activity-theoretical approach to development research.* Helsinki: Orienta-Konsultit Oy.

Engeström, Y. (1990). *Learning, Working and Imagining. Twelve studies in activity theory*. Helsinki: Orienta-Konsultit Oy.

Engeström, Y. (1993). Work as a test bench of activity theory. In S. Chaiklin and J. Lave (Eds.). *Understanding Practice. Perspectives on activity and context.* Cambridge: Cambridge University Press

Engeström, Y. (1996). The tensions of judging. Handling cases of driving under the influence of alcohol in Finland and in California. In Y. Engeström and D. Middleton (Eds). *Cognition and Communication at Work* (pp. 199–232). Cambridge: Cambridge University Press.

Engeström, Y. (1999). Learning by Expanding. Ten years after. Introduction in *Lernen Durch Expansion* (The German edition of Learning by Expanding). Marburg: BdWi-Verlag

Engeström, Y. (2000). Activity theory as a framework for analyzing and redesigning work. In *Ergonomics 43(7)*, 960–974.

Engeström, Y., Miettinen, R. and Punamäki, R-L. (Eds.). (1999). *Perspectives on Activity Theory*. Cambridge: Cambridge University Press.

European Commission (2000). *Science Policies in the European Union: Promoting excellence through mainstreaming gender equality*. (A report from the ETAN expert working group on women and science). Luxembourg: Office for official publications of the European communities. Retrieved May 16th, 2008 from the Europa server at ftp://ftp.cordis.europa.eu/pub/etan/ docs/women.pdf

European Commission (2003). *Waste of Talents: turning private struggles into a public issue. Women and science in the ENWISE countries*. Luxembourg: Office for official publications of the European communities. Retrieved May 14th, 2008 from the Europa server at http://ec.europa.eu/research/science-society/pdf/enwise_report.pdf

European Commission (2004a). *SHE-figures 2003. Women and Science Statistics and Indicators*. Luxembourg: Office for official publications of the European communities. Retrieved August 26th, 2008 from the Europa server at http://ec.europa.eu/research/science-society/pdf/she_figures_2003.pdf

European Commission (2004b). *Europe Needs More Scientists. Report by the high level group on increasing human resources for science and technology in Europe.* Luxembourg: Office for official publications of the European communities. Retrieved May 9th, 2008 from the Europa Server at

http://ec.europa.eu/research/conferences/2004/sciprof/publications_en.html

European Commission (2005). *Women and Science – Excellence and Innovation. Gender equality in science*. (Commission staff working document). Luxembourg: Office for official publications of the European communities. Retrieved June 9th, 2008 from the Europa server at http://ec.europa.eu/research/science-society/pdf/documents_women_sec_en.pdf

European Commission (2006). *SHE-figures 2006. Women and Science Statistics and Indicators*. Luxembourg: Office for official publications of the European communities. Retrieved August 26th, 2008 from the Europa server at http://ec.europa.eu/research/science-society/pdf/she_figures_2006_en.pdf

European Commission (2008). *Mapping the Maze: Getting more women to the top in research*. Luxembourg: Office for official publications of the European communities. Retrieved May 9th 2008 from the Europa server at http://ec.europa.eu/research/science-society/document_library/pdf_06/mapping-the-maze-getting-more-women-to-the-top-in-research_en.pdf

Foucault, M. (1982). The Subject and the Power. In H. L. Dreyfus and P. Rabinow (Eds.). *Michael Foucault. Beyond Structuralism and Hermeneutics* (pp. 208–226). Chicago: University of Chicago Press.

Keller, E. F. (1985). *Reflection on Gender and Science.* New Haven, Connecticut: Yale University Press.

Gherardi, S. (1995). *Gender, Symbolism and Organizational Cultures*. London: Sage.

Gilligan, C. (1977). In a different voice. Women's conceptions of self and morality. In *Harvard Education Review (47),* 481–517.

Haraway, D. (1991). *Simians, Cyborgs and Women.* London: Free Association Books.

Haraway, D. (1992). The Promises of Monsters. A Regenerative Politics for Inappropriate/d Others. In L. Grossberg, C. Nelson and P. A. Treichler (Eds.). *Cultural Studies* (pp. 295–337). New York: Routledge.

Harding, S. (1986). *The Science Question in Feminism.* New York: Cornell University Press.

Hasse, C. (2002). *Kultur i Bevægelse. Fra deltagerobservation til kulturanalyse – i det fysiske rum*. Frederiksberg: Samfundlitteratur.

Hasse, C. (2005). Køn som stopklods og solstråle. In *Køn, Karakter og Karriere – Drenges og pigers præstationer i uddannelse* (pp. 53–70). Copenhagen: Danmarks Evalueringsinstitut.

Hasse, C. (2008). Cultural models of gender in science. An analysis of different historical connections made between hard sciences, humanities and gender in physics in two countries in Europe. In P. Valero and O.

Skovmose (Eds.). *University Science and Mathematics Education – Challenges and Possibilities*. Hamburg: Springer.

Hasse, C., Sinding, A.B. and Trentemøller, S. (Eds.). (2008a). *Draw the Line! University as workplaces for male and female researchers in Europe*. Tartu: Tartu University Press.

Hasse, C., Sinding, A.B. and Trentemøller, S. (2008b). UPGEM National Report Denmark. In C. Hasse, A.B. Sinding and S. Trentemøller (Eds.). *Draw the Line! University as workplaces for male and female researchers in Europe* (pp. 20–136). Tartu: Tartu University Press.

Hasse, C., Trentemøller, S. and Sinding, A.B. (2008c) *Draw the Line! InternationalConference, Copenhagen 2008. Papers, proceedings and recommendations.* Tartu: Tartu University Press.

Hasse, C and Trentemøller, S. (forthcoming). Kulturkontrast som metodetilgang. In S. H. Pedersen, L. Kragelund and B. R. Thorsen (Eds.). *Metodiske Dilemmaer ved Forskning i Arbejdspladslæring.* Copenhagen: Danmarks Pædagogiske Universitetsforlag.

Hasu, M. (2000). Constructing clinical use: An activity-theoretical perspective on implementing new technology. In *Technology Analysis and Strategic Management (12)*, 369–382.

Holland, D. (1992). The woman who climbed up the house. Some limitations of schema theory. In T. Schwartz, G. White and C. Lutz (Eds.). *New Directions in Psychological Anthropology*. Cambridge: Cambridge University Press.

Holland, D., Lachicotte W. Jr., Skinner D. and Cain C. (Eds.). (1998). *Identity and Agency in Cultural Worlds* . Cambridge: Harvard University Press.

Holland, D. and Cole, M. (1995). Between Discourse and Schema: Reformulating a cultural-historical approach to culture and mind. In *Anthropology and Education Quarterly, 26(4).* 475–490.

Holland, D. and Quinn, N. (1987a). (Eds.). *Cultural Models in Language and Thought*. Cambridge: Cambridge University Press.

Holland, D. and Quinn, N. (1987b). Preface & Culture and Cognition. In *Cultural Models in Language and Thought* (pp. vii–x, 3–40) Cambridge: Cambridge University Press.

Ihde, D. (1995). *Postphenomenology. Essays in the postmodern context*. Evanston: Northwestern University Press.

Inglehart, R. and Norris, P. (2003). *Rising Tide. Gender equality and cultural change around the world***.** Cambridge: Cambridge University Press.

Knorr-Cetina, K. (1999). *Epistemic Cultures: How the Sciences Make Knowledge*. Harvard: Harvard University Press.

Kvale, S. (1994). *Interview. En introduktion til det kvalitative forskningsinterview.* Copenhagen: Hans Reitzels Forlag.

Lave, J. and Wenger, E. (1991). *Situated Learning. Legitimate peripheral participation.* Cambridge: Cambridge University Press.

Latour, B. (1987). *Science in Action. How to follow scientists and engineers through society.* Cambridge Mass.: Harvard University Press.

Latour, B. (1993). *We Have Never Been Modern*. London: Prentice Hall.

Lõhkivi, E. (2008). Social Changes and Changes in Science Management. The Estonian Case. In C. Hasse, S. Trentemøller and A.B. Sinding (Eds.). *Draw the Line! International Conference, Copenhagen 2008. Papers, proceedings and recommendations* (pp. 93–98). Tartu: Tartu University Press.

Marcus, G. (1995). Ethnography in/of the world system. The emergence of multi-sited ethnography. In *Annual Review of Anthropology*, *24*, 95–117.

Megaw, W.J. (1991). *Gender Distribution in the World's Physics Departments*. (Report presented at the international meeting on gender and science and technology. Melbourne, Australia).

Nader, L. (1994). Comparative Consciousness. In R. Borofsky (Ed.) *Assessing Cultural Anthropology*. New York: McGraw-Hill.

Peacock, J. and Holland, D. (1993). The narrated self. Life stories in process. In *Ethos*, 21(4), 367–383.

Pike, K. (1967). *Language in Relation to a Unified Theory of the Structure of Human Behaviour.* New York: Mouton De Gruyter.

Qvortrup, L. (2008). The UPGEM Conference Welcome Speech. In C. Hasse, S. Trentemøller and A.B. Sinding (Eds.). *Draw the Line! International Conference, Copenhagen 2008. Papers, proceedings and recommendations* (pp. 44–46). Tartu: Tartu University Press.

Reid, R. and Traweek. S. (Eds.). (2000). *Doing Culture + Science*. New York: Routledge.

Rees, T. (2002). *National Policies on Women and Science in Europe*. The Helsinki group on women and science. Luxembourg: Office for official publications of the European communities. Retrieved May 9th 2008 from the European server at ftp://ftp.cordis.europa.eu/pub/improving/docs/women_national_policies_part_1.pdf

Reyneri, E. (2001). *Migrants in Irregular Employment in the Mediterranean Countries of the European Union*. (International Migration Paper No. 41). Geneva: ILO.

Rosser, S.V. (2004). *The Science Glass Ceiling. Academic scientist and the struggle to succeed*. London: Routledge.

Rubin, G. (1975). The Traffic in Women. Notes on the 'Political Economy' of Sex. In R. R.

Reiter (Ed.). *Toward an Anthropology of Women* (pp. 157–210). New York: Monthly Review Press.

Saari, E. (2003). *The Pulse of Change in Research Work. Development of the object of research, collaboration and the division of labour in a research group*. Academic dissertation. Helsinki: Helsinki University Press.

Scott, J. W. (1999). Gender as a useful category of historical analysis. In R. Parker and P. Aggleton (Eds.). *Culture, Sexuality and Society. A Reader*. London and Philadelphia: UCL Press.

Seppänen, L. (2000). Activity theoretical view on crop rotation planning in organic vegetable farming. In *Fourth European symposium on European farming and rural systems research and extension. Proceedings* (pp. 283–292).

Seppänen, L. (2002). Societal integration in organic vegetable farming: exploring the learning challenges. In *The Journal of Agricultural Education and Extension, 8(2)*, 87–100.

Strauss, C. (1992). What makes Tony Run? Schemas as motives reconsidered. In R. D'Andrade and C. Strauss (Eds.). *Human Motives and Cultural Models* (pp. 191–224). Cambridge: Cambridge University Press.

Svinth, L. (2008). Women in physical science. In C. Hasse, S. Trentemøller and A.B. Sinding (Eds.). *Draw the Line! International Conference, Copenhagen 2008. Papers, proceedings and recommendations* (pp. 19–43). Tartu: Tartu University Press.

Thörngren, P.E., Tengblad, U., Wiesner, K., Janssens, K., Marks, A., McGrath, S., Molinari, E. and Stephenson, S. (2002). Learning from regional differences. In B.K. Hartline and D. Li. (Eds.). *Women in Physics. The IUPAP International Conference on Women in Physics* (pp. 25–28). New York: American Institute of Physics.

Traweek. S. (1988). *Beamtimes and Lifetimes. The world of high energy physics*. Cambridge: Harvard University Press.

Vainio, J. (2008). UPGEM National Report Finland. In C. Hasse, A.B. Sinding and S. Trentemøller (Eds.). *Draw the Line! University as workplaces for male and female researchers in Europe* (pp. 213–262). Tartu: Tartu University Press.

Velbaum, K., Lõhkivi, E. and Tina, M.L. (2008). UPGEM National Report Estonia. In C. Hasse, A.B. Sinding and S. Trentemøller (Eds.). *Draw the Line! University as workplaces for male and female researchers in Europe* (pp. 137–212). Tartu: Tartu University Press.

Vygotsky, L. (1987). Thinking and speech. In R.W. Rieber and A. S. Carton (Eds.). *The Collected Works of L. S. Vygotsky*. (Vol. 1, pp. 1–16). New York: Plenum Publishing.

Weber, M. (1905). *The Protestant Ethic and the Spirit of Capitalism*. New York: Charles Scribner's Sons.

APPENDIX I

Overview of Women in Science in Selected European Countries

Agata Heymowski

The UPGEM countries cover a wide area of Europe from the South to the North. They also include aspects such as being a small population versus bigger population as well as different religion and political histories. However, when we compare the quantitative figures of women in natural sciences from the UPGEM countries with numbers from other European countries (Svinth 2008), we see indications that the cultural variations found in the UPGEM project may only be a small piece of the puzzle. Therefore, we would like to investigate further the issue of cultural diversity in relation to some of the European countries with a high representation of female scientists. Here we have found Bulgaria, Portugal, Romania, Slovenia, Hungary and Spain to be particularly interesting.

Table I. Percentage of Women in Science in Bulgaria, Portugal, Romania, Slovenia, Hungary and Spain.

Country	*% of women in science*
Bulgaria	46.2
Portugal	43.5
Romania	43.0
Slovenia	36.0
Hungary	34.5
Spain	30.9

Sources: Rees 2002, European Commission 2003; 2004.

APPENDIX

Southern European Countries

Cultural historical developments in Spain

Spanish women have been allowed to enrol for primary education since 1857. A decree of 1868, which was aimed at restructuring secondary education and the university faculties, did not distinguish between sexes and enabled women (though only a few did) to complete with the men at the different educational levels. However, not until 1910 were female students formally treated as equals (Bösch 2003). In 1916 Spain gained its first female professor at university. A recent review of the situation of women in science in Spain (Navas 2002), shows that women make up 30.9% of research staff at the High Council for Scientific Research. Currently more than 53% of the university students are female. Even though the percentage of female academic staff is lower than the general employment rate of Spanish women, affirmative actions have not until recently been introduced at Spanish universities.

Regarding reconciliation of parenthood and university careers, Spanish universities are not obliged to offer childcare facilities to their employees. Universidad Complutense de Madrid which has more than 6000 teachers (Departamento de Análisis y Planificación 2000, 21) does not provide such a service (Bösch 2003).

In October 2000, the Observatory for Equal Opportunities for women and men was created. The purpose is to generate information about the situation of women in relation to the situation of men and the effects of institutional policies aiming at promoting the participation of women in all fields in academia.

Historically speaking, physics has received only a little attention in Spain due to religious and social reasons. Spanish school children first become acquainted with physics at the age of 13. Here physics is taught together with chemistry and the teachers are usually chemists. To attract students to study physics the Spanish Physical Society (RSEF) organizes special programs (e.g. Physics on Stage) in collaboration with several European institutions including the European Laboratory for Particle Physics (CERN), the European Space Agency (ESA) and the European Southern Observatory (ESO). Women constitute 30% of all graduated students in physics. In the higher research positions, the percentage of female physics professors is approximately 25% but only 3% for full professors (Carreras et al. 2002).

Cultural historical developments in Portugal

Looking at the list in Table 1, we see that the overall representation of women in science is relatively high in Portugal with 43.5% of female scientists in the research sector. As the Portuguese National Report[40] (from the Helsinki Group) shows, a number of historical reasons relating to social and political aspects appear to partly explain the relatively high number of women scientists, especially in natural sciences, in Portugal. One of the reasons, the report points to, is social selectivity in the sense that women's access to higher education was either, or both facilitated by and determined by their social status. Before 1974 the higher education system typically only accepted students (irrespective of gender) of a more privileged background (Reis et al. 2001).

Of the countries reported on here in Appendix 1 Portugal has the second highest percentage of female scientists in the natural sciences of 43.5%. Furthermore, we also find a high percentage of female full professors in physics (i.e. 26%). Moreover, notably 74% of the high school teachers in physics and chemistry are women (Providencia, Costa and Eiro 2002).

In Portugal, salaries in general and in the R&D (Research and Development) sector are low. Consequently, it is imperative for many families that the mother also takes up work outside the domestic sphere. For this to be possible, Portugal has organized structures for child care, but and possibly even more importantly the general Portuguese family structure is the extended family in which many collaborate in the up bringing up of the children.

Competition in academia (including physics) has increased over that last few years and promotions are often found in an international career. For that reason it has become harder for female scientists/physicists to reconcile work and family life.

Eastern European Countries

Gender in the communist period

The Communist gender policy stressed the importance of education and worked for access to education for all, irrespective of gender. This policy has resulted in the emergence of a high proportion of well-educated women, who are active in all areas of the public spheres, but notably in science.

[40] Available at http://ec.europa.eu/research/science-society/pdf/women_national_report_portugal.pdf

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In central and eastern European countries, gender differentiation was less evident during the Communist period compared to non-communist countries; school programmes were identical for both sexes, and girls as well as boys were expected to learn technical studies. Significant numbers of women were employed in professions that were, and still are, predominantly male in Western Europe. With these school programmes, the goal of gender equality was considered fulfilled in most central and eastern European countries. There was no public discussion about gender equality or women's silent burden of the responsibility for the family.

In this respect, the Communist period can be said to be characteristic of both a high degree of independence and professional activities for women and relatively conservative gender roles.

Cultural historical developments in Slovenia

During the Communist period, Slovenia was part of the Socialist Federal Republic of Yugoslavia. Yugoslavia was a communist country that was not affiliated to any of the Soviet organisations, i.e. the Warsaw Pact, Communist Bloc or Soviet Union. In the latest three decades, the representation of post graduate women has increased to 65% and the representation of female Ph.D.s has increased to 46% (Mladenić 2008).

An important first step toward the elimination of gender inequality was taken in the first socialist Constitution of Federal Republic of Yugoslavia (as well in the Constitution of Republic of Slovenia) in 1946 by the constitutionally guaranteed equality of women with men in all fields of state, economic and social life (Jogan 2002). Important changes came later, with the increasing role of women in society from the 1970s to the 1980s (many day-care institutions were opened for small children and legal possibility of the division of maternity leave between the parents was introduced). The communist system recognised the importance of education and provided free education from primary school until university graduation, and during the last decade of the Communist period more women than men graduated from university. In 1991 Slovenia became an independent state and the successive transitional period resulted in a revival of patriarchal dominance (e.g. the proportion of women in parliament dropped from 26% in 1970 to 12% in 2004). The situation of women in science in Slovenia did not change dramatically in spite of the transition in the political system. Nevertheless, there are various obstacles for women's academic career as is clearly recognized by a research report (Jogan 1997) that investigated a sample of 71 female teaching assistants and 41 female assistant professors at the universities of Ljubljana and Maribor in 1996 (the only two universities in Slovenia). The

report identified problems of hidden discrimination and strict control of women, lack of support in the working environment, a 'chilly' social climate, negative prejudice towards women and a great load of teaching tasks. Moreover, the work imposed on women created worse conditions (in comparison to the male scientists) for their research and publishing. The report further underlines the overburdening of women by household chores and family responsibilities. One of the female assistant professors stated: *"Women in academy are not deprived unless they have children"* (ibid.). In spite of the reported obstacles, the proportion of female scientists compared to male scientists in academic research is still higher in Slovenia than in Western Europe.

In Slovenia there is no special body at the level of university and research institutes dealing with gender equality issues, although numerous non-governmental organizations are active in various women-related fields. The first unit for gender equality was established in 2006 at the newest university, the University of Primorska (founded in 2004). The field of science and research has only one network for women, which is the network for Women in Physics (Jogan et al. 2006). Nevertheless, women's position in science and research in Slovenia has generally not been invisible or neglected in the recent past.

In Slovenia the representation of women in physics continues to increase, but the percentage of female physicists is still low in comparison to other scientific fields. In elementary and middle school the physics teachers are mostly women, whereas researchers in physics or physics teachers at university are mostly men. A statistical survey completed in 1999–2000 shows that women have constituted 19% of the postgraduate students in physics and 15% of Ph.D.s (Borstnik et al. 2002).

Cultural historical developments in Romania

According to previous research, female researchers represent 43% of the total Romanian research staff (European Commission 2006). The number of educated women who have acquired scientific training and taken up a research career is notably high in Romania (as in other eastern European countries). Moreover, women are not only present in almost all of the science fields in Romania but also in higher numbers compared to the men. Since the post-war period, Romania has generally considered women equal to men in all economic and social fields. Nonetheless, we still find only few women managers, rectors and full professors in e.g. the R&D sector (Rees 2002). Additionally, the representation of women in evaluation panels, advisory groups, data bases of experts and programme committees is low (Dumitrescu 2008). Like many female scientists in the post-communist countries, the

Romanian female scientists must also overcome a number of problems concerning unavailability of funding, rigid patterns of promotion and recognition or lack of appropriate welfare policies.

During the communist period, Romania was an independent nation state which as a Warsaw Pact member was influenced by the USSR. In 2002, Romania signed a Cooperation Agreement with CERN which is much later than other Soviet Bloc countries (e.g. Slovenia, Bulgaria, Poland, Hungary) which cooperated with CERN during the Communist period.

The percentage of women in natural science is quite high compared to western European countries. Statistics from 2000 show that in Romania the total percentage of graduates in hard science, engineering, manufacturing and construction was 55% and of these 36% were women (European Commission 2004). Consequently, physics in Romania seems to be as attractive a field to study as it was during the communist period, and 49% of all graduate students in physics are women. Visinescu et al. (2002) find that Romanian female physicists emphasise that there has been no explicit resistance to the access of young women to higher scientific education and academic positions in physics. Nevertheless, a large proportion of the young female physicists often go abroad to the United States or Western Europe to complete their Ph.D. degree. Only a small number of these women return to Romania.

Cultural historical developments in Hungary

Women in Hungary have been able to study at universities since 1895. The statistics show that since 1955 more women than men have attended basic training of higher education. In the academic year of 2004/2005, 59% of the students attending university were women and the proportion of women attending Ph.D. or MA courses increased to 44.5%. Looking at the gender distribution among the participants in Ph.D. science programmes, in 2005, we find a high percentage of women, 40.1%.

The work and family life balance seems to be a great challenge at all the institutional levels in Hungary. The balance between work and private life has never received much attention in this country. Some universities have kindergarten and nursery school for the children and grandchildren of the employees, but in general there is a lack of acceptance of parents staying home with their children. Issues of maternity are still a question of agreement between the leader of the given unit and the employee, and such questions are typically to be settled between the leader and the female employees. Many female scientists from Budapest University of Technology and Economics emphasise that they can continue their scientific career because of great support from their families, particularly their parents (primarily regarding childcare and house chores). In

this case they share characteristics with Poland and Italy (Chudzicka-Dudzik, Diekmann, Miazek and Oleksy 2008; Ajello, Belardi and Calafiore 2008).

> *My mother-in-law had always been available since the birth of the children and helped a lot. I never had to stay at home with the children when they were ill and could not go to the nursery school, because their grandmother took care of them. You can not manage it without the help of the family.*
> (Female chemical engineer and associate professor at university in Palasik 2007, 53).

Other factors which play an important role for the Hungarian female scientists in successful scientific careers are diligence, endurance, supportive professional workplace, and good relationships especially with the influential researchers (Palasik 2007, 45). Interestingly from the perspective of much gender research, the male scientists emphasized more so than the female scientists the importance of a good family background (marriage) as a protective and supporting factor in a scientific career. Among the women, a family, however, represented a risk factor which impedes the scientific career (ibid.). A female scientist stated: *"I can only recommended every women not to give birth to her child where she wants to build a career"* (chemical engineer and associate professor at university (ibid., 54). Nevertheless, more male Ph.D.s than female Ph.D.s consider leaving academia within five years while a large proportion of the female Ph.D.s decided to continue as a researcher after finishing their PhDs.

According to the UNICAFE report[41], Hungary is referred to as patriarchal as most household chores are perceived to be the responsibility of the women, women get less in salary compared to men[42] (ibid.) Nonetheless, the percentage of female scientists is higher in Hungary compared to many Western countries, as is the percentage of women obtaining an academic degree. The Hungarian Academy of Science has set up a reform plan (in cooperation with the Helsinki Group) to support the career of female researchers e.g. by creating family friendly workplaces, establishing special prizes and grants for women. The plan was proposed as a government resolution was but was never agreed upon (Palasik and Papp 2008).

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[41] Available at http://www.unicafe.ee/Failid/report_bme_eng.pdf

[42] With respect to executive salaries, women get lower salaries than men, but at the general level there is no reported difference in the salary of men and women.

Physics is taught at four universities in Hungary and, according to Judith Nemeth`s conference paper (2002), the majority of the students studying to be physics teachers are girls. Among the research students the women only constitute 10-12%. Nemeth underlines that the majority of female physicists who finished university training in recent years have either left physics or work as experimental physicists. A number of female physicists have decided to postpone marriage and children and, in fact, the most successful female physicists are among these women. Only few of the women seem to be successful at combining family life and career. Nemeth draws attention to the fact, that Hungary is a small country with few research positions. In order to keep up in the competition for these positions (with the male physicists) the women must go abroad as part of their Ph.D. studies and postdoctoral studies in order to gain the sufficient research experience. The need to go abroad has an influence on family life wherefore some of the female physicists decide to not have a family before the age of 32–35 (Nemeth 2002).

Cultural historical developments in Bulgaria

Similar to the other post-communist countries, Bulgaria has since 1989 undergone a transformation from communism to democracy and market economy. However, the transformation did not necessarily benefit the cause of gender equality. The post-communist gender arrangements initiated a radically different social policy and official gender ideology, which affects women more than men. Women in general have lost some of the benefits they enjoyed under the communist period such as job security, social insurance and labour protection for mothers (Luleva 2006). That the new legislation has abandoned the old socialistic policy of encouraging the having ofchildren has affected workplace policies regarding mothers, and, in fact, the present gender discourse is reaffirming the stereotypical concept of mothering and marriage as the ‘natural vocation’ of women. Nevertheless, the younger generation of women and men appear to have an open mind to an egalitarian and more partner-oriented gender construction.

Bulgarian women have had access to higher education in academia science 1897 and universal suffrage since 1937. On May 29, 1924 the Bulgarian Association of University Women (BAUW) was founded. Its key goals were to bring together educated women and encourage them to pursue either, or both academic and public careers; to ensure a closer cooperation among women in professional activities; to fight for professional equality between men and women as well as against social injustice; to strengthen the education of young people and to take care of female university students. Unfortunately, after World Word II the state confiscated the ownership of the association in

1948. The organizational life of BAUW was suspended and in the mid-1950s the communists closed it down as it was perceived to be an association of (anti-communist) intelligentsia (Luleva, 2006). However, In 1990 BAUW was restored as the only measure to promote women in science in Bulgaria. Nevertheless, the representation of women in academia has increased, and statistics shows that in 2006/2007 the percentage of women at, for example, the University of Sofia was 63% (Koleva 2007). Statistics also show that the percentage of female Ph.D. students in the R&D sector was 47% in 2003. According to the statistics from Simeonova (2001), Bulgaria had the highest percentage of female Ph.D. students in natural sciences (i.e. 57%) in 1999. Nevertheless, higher academic and research positions are still dominated by men, and awareness and understanding of equal opportunities for women and men in the research sector is still not widespread.

The representation of female physicists was very high in former communist countries. Bulgaria has one of the highest percentage of women studying physics (at undergraduate level), and in all women constitute 50% of the total number of physics students. Bulgarian female physicists face the same problem as female physicists in Slovenia, Romania or Hungary; the Government provides no financial support, and most contributions come via international collaborations. As a result many female physicists have found it necessary to work abroad in order to improve their research. In spite of the high representation, it is still difficult for female physicists to obtain a higher research positions. The University of Sofia only has two female full professors in physics (total number of full professors is 18). Furthermore, there are no women managers at the Physics Faculty at the University of Sofia (Proyokova 2002).

The quotation below describes a case of gender discriminating behaviour (during the Communist period) at the Bulgarian Academy of Science:

> *In 1976 the Institute for Philosophical Research of the Bulgarian Academy of Science announced a competition for a grant for doctoral study in Philosophy of Science at the Institute. I entered the competition together with four other graduates. At this competition, and male physicist and I scored highest with equal marks. The man was preferred. Then, I asked the head of the Philosophy of Science department: "Why did you prefer the other person?" having in mind that both of us were physicists and both of us had scored equal marks. The answer was short, simple and natural: "Because he is a man, but do not worry! Next year will be a new competition for a doctoral grant at my department, and you are welcome to*

try again". I was not pleased by this reply, but I was not angry either, because I found it ***natural*** *– the things are as they were, fixed and unchangeable and I could not do anything. At the time I lacked sensitivity for discrimination. Only later (1990), after my participation in an international project on 'Gender Gap in Higher Education', I realised for the first time that in 1976 I had been in fact discriminated against, but that time I was not aware of it.*

(Dr. Nikolina Sretenova, philosopher and physicist and Bulgarian member of the Enwise Expert Group, in European Commission 2003, 27)

Reference list

European Commission (2003). *Waste of Talents: turning private struggles into a public issue. Women and science in the ENWISE countries*. Luxembourg: Office for official publications of the European communities. Retrieved June 16th, 2008 from the Europa server at http://ec.europa.eu/research/science-society/pdf/enwise_report.pdf

European Commission (2004). *SHE-figures 2003. Women and Science Statistics and Indicators*. Luxembourg: Office for official publications of the European communities. Retrieved August 26th, 2008 from the Europa server at http://ec.europa.eu/research/science-society/pdf/she_figures_2003.pdf

Rees, T. (2002). *National Policies on Women and Science in Europe*. (The Helsinki group on women and science). Luxembourg: Office for official publications of the European communities. Retrieved May 9th 2008 from the Europa server at ftp://ftp.cordis.europa.eu/pub/improving/docs/women_national_policies_part_1.pdf

Svinth, L. (2008). Women in physical science. In C. Hasse, S. Trentemøller and A.B. Sinding (Eds.). *Draw the Line! International Conference, Copenhagen 2008. Papers, proceedings and recommendations* (pp. 19–43). Tartu: Tartu University Press.

References for Spain

Bösch, J. (2003). *Women in Spanish Universities*. Retrieved June 15th at http://csn.unimuenster.de/women-eu/download/Boesch00_07.pdf

Carreras, C. et al. (2002). *Women in Physics in Spain.* (Conference paper presented at the IUPAP international conference on women in physics). Paris, France.

Departamento de Análisis y Planificación (Ed.) (2000). *Guía de la Universidad Complutense 2000–2001.* Salamanca, Spain.

Navas, E. (2002). *Women and Science: Review of the situation in Spain".* (Spanish national report conducted for The Helsinki Group on women and science). Retrieved June 15th from the Europa server at http://ec.europa.eu/research/science-society/pdf/women_ national_report_spain.pdf

References for Portugal

Providencia, C., Costa, M.M.R and Eiro, A.M. (2002). *A Physics Career for Women in Portugal.* (Conference paper presented at the IUPAP international conference on women in physics). Paris, France.

Reis, A.L. et al. (2001). *Women and Science: Review of the situation in Portugal*. (Portuguese national report conducted for The Helsinki Group on women and science). Retrieved August 15th from the Europa server at http://ec.europa.eu/research/sciencesociety/pdf/women_national_report_portugal.pdf

References for Slovenia

Borstnik, J.N., Remskar, M. and Gombos, A. (2002). *Women in Physics in Slovenia.* (Conference paper presented at the IUPAP international conference on women in physics). Paris, France.

Jogan, M. (1997). *The Situation of Women Scientists in Slovenia.* (Research report). Ljubljana: Fakulteta za druzebne vede.

Jogan, M. (2002). *Women and Science – the Situation in Slovenia.* (Paper presented at the international conference 'Forum Bled 2002'). Bled, Slovenia.

Jogan, M., Majerhold, K., Mladenic, D. and Venturini, A.U. (2006). *Enwise Follow-up Activities in Slovenia: Whose problem?* (D8.3.1: Slovenian national report. Central European centre for women and youth in science). Ljubljana: J. Stefan Institute.

Mladenić, D. (2008) Women in Science. Slovenia: to be or not to be a woman in science. In M. Linková, D. Mladenić, E.H. Oleksy, M. Palasik, E. Papp, M. Piscová and D. Velichová *Re-claiming a Political Voice: Women and science in Central Europe*. (pp. 205–230) Prague: Institute of sociology of the academy of science of the Czech Republic.

References for Romania

Dumitrescu, A.L. (2008). *An Eastern European Perspective on the Integration of Women Scientists in the European Research Area.* (Paper presented at the EPWS annual conference 'Women Shaping Science'. Vilnius, Lithuania.

European Commission (2004). *Eurostat Yearbook 2004. The statistical guide to Europe*. Luxembourg: Office for official publications of the European communities.

European Commission (2006). *SHE-figures 2006. Women and science statistics and indicators*. Luxembourg: Office for official publications of the European communities. Retrieved August 26th, 2008 from the Europa server at http://ec.europa.eu/research/sciencesociety/pdf/she_figures_2006_en.pdf

Rees, T. (2002). *National Policies on Women and Science in Europe*. (The Helsinki group on women and science). Luxembourg: Office for official publications of the European communities. Retrieved May 9th 2008 from the Europa server at ftp://ftp.cordis.europa.eu/pub/improving/docs/women_national_policies_ part_1.pdf

Visinescu, A., Adam, S., Georgescu, V. and Balint, A. (2002). *Cultural, Societal and Professional Features of a Woman's Career in Physics in Romania.* (Conference paper presented at the IUPAP international conference on women in physics). Paris, France.

References for Hungary

Ajello, A.M., Belardi, C. and Calafiore, G. (2008). UPGEM National Report Italy. In C. Hasse, A.B. Sinding and S. Trentemøller (Eds.). *Draw the Line! University as workplaces for male and female researchers in Europe* (pp. 263–366). Tartu: Tartu University Press.

Chudzicka-Dudzik, P., Diekmann, A., Miazek, M. and Oleksy, E. (2008). UPGEM National Report Poland. In *Full Collection of National Reports. Universities as workplaces for male and female researchers in Europe* (pp. 362–441). Retrieved August 14th at http://www.dpu.dk/Everest/Publications/Subsites/UPGEM/20080812161221/CurrentVersionFull%20Collection%20of%20National%20Reports_b.pdf

Nemeth, J. (2002). *Physics in Hungary.* (Conference paper by Judith Nemeth (Conference paper presented at the IUPAP international conference on women in physics). Paris, France.

Palasik, M. (Ed). (2007). *UNICAFE. Survey of the University Career of Female Scientists at Life Sciences Versus Technical Universities.* Budapest: Budapest university of technology and economics.

Palasik, M. and Papp, E. (2008). *Women in Science: Overview of Hungary.* In M. Linková, D. Mladenić, E.H. Oleksy, M. Palasik, E. Papp, M. Piscová and D. Velichová *Re-claiming a Political Voice: Women and science in Central Europe*. Prague: Institute of sociology of the academy of science of the Czech Republic.

APPENDIX

References for Bulgaria

European Commission (2003). *Waste of Talents: Turning private struggles into a public issue. Women and science in the Enwise countries.* Luxembourg: Office for official publications of the European communities. Retrieved June 19th, 2008 from the Europa server at http://ec.europa.eu/research/science-society/pdf/enwise_report.pdf

Koleva, D. (2007). *Feminisation of University Education?* (Conference paper presented at the Sofia conference held by the international federation for research in women's history. Sofia, Bulgaria.

Luleva, A. (2006). Transformation and gender arrangements in postsocialist Bulgaria. In *Ethnolocia Bulgarica. Yearbook of Bulgarian Ethnology and Folklore 2006(3)*, 12–22.

Proyokova, A. (2002). *The Status of Women in Physics in Bulgaria.* (Conference paper presented at the IUPAP international conference on women in physics). Paris, France.

Simeonova, K. (2001). *Women and Science. Review of the Situation in Bulgaria.* (Bulgarian national report conducted by The Helsinki Group on women and science). Retrieved August 13th from the Europa server at http://ec.europa.eu/research/sciencesociety/pdf/womennational_ report_bulgaria.pdf

APPENDIX II

Physicist couples (endogamic relationships) in the UPGEM data material

Anne Bjerregaard Sinding and Katrin Velbaum

Some of the 208 interviewees are or have been in endogamic relationships. Below, a counting distributed among countries, gender and stayer/leaver position is available. The numbers cover all interviewees who are married to, live together with, or are in a stable relationship with another physicist, as well as interviewees who are divorced from, or have lived together with another physicist.

Table 1. UPGEM interviewees in endogamic relationship

Country	Female leavers	Male leavers	Female stayers	Male stayers
Denmark *(N=36)*	P15	P30	P7	P17
	P18		P13	P20
	P26		P14	
	P31		P16	
			P19	
			P21	
Estonia *(N=36)*	P182	P187	P188	P209
	P183		P190	
	P198		P191	
	P200		P192	
			P193	
Finland *(N=36)*	P140	P168	P138	P172
	P157		P139	
	P164		P144	
			P154	
			P173	

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Country	Female leavers	Male leavers	Female stayers	Male stayers
Italy *(N=50)*	P44		P55	P57
	P49		P58	P59
			P64	
			P73	
			P74	
			P80	
			P82	
Poland *(n=50)*	P92	P100	P107	P87
	P93	P119	P108	
	P105	P135	P110	
	P111		P125	
	P122		P131	
	P128			

Endogamic relationships are often referred to in the UPGEM interviews. As it appears from the table, it is much more common for female physicists to be/have been in a relationship with another physicist than for male physicists. This is not surprising when considering the low numbers of women and high numbers of men in physics in general. However, it is interesting that we do *not* find any clear pattern that being in a relationship with another physicist should promote women's career opportunities. In this respect it is also worth noting that many of the female leavers are actually in a relationship with male physicists who are leavers, too.

APPENDIX III

Representation of Women in the UPGEM Head Count

The proportion of women at different levels of research positions in the five UPGEM countries

	Ph.D. student		**Post Doctoral**		**Assistant Professor**		**Associate Professor**		**Professor**	
Country	Total*	Women %	Total	Women %	Total	Women %	Total	Women %	Total	Women %
Denmark	199	**24**	100	**17**	36	**11**	135	**10**	79	**3**
Finland	325	**23**	102	**21**	48	**8**	51	**12**	82	**9**
Estonia	84	**27**	4	**0**	72	**22**	95	**11**	30	**7**
Poland	355	**37**	22	**18**	281	**24**	183	**14**	175	**13**
Italy	89	**40**	35	**34**	219	**26**	177	**33**	180	**23**

(Total refers to the total number of male and female physicists.)

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This Table is also published as 'Table 26. The proportion of women at different levels of research positions in the five UPGEM countries' in Svinth (2008, 41).

Reference list

Svinth, L. (2008). Women in physical science. In C. Hasse, S. Trentemøller and A.B. Sinding (Eds.). *Draw the Line! International Conference, Copenhagen 2008. Papers, proceedings and recommendations* (pp. 19–43). Tartu: Tartu University Press.