Sharing Fragile Future

- feminist technoscience in contexts of implication

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In memory of my mother Ing-Britt and my father Uno

Contents

Abstract

Like a winding string passing tryings at risk, this book is my endeavour to make explicit the situatedness and responsibility of research and researchers in the trouble, let it be in the 'grand challenges' of our time or in the very local challenges of survival. Efforts to promote more complex and integrated understandings of 'society in science' or science as a political arena is urgent when facing the incalculabilities in our late modern spheres of society. There is no doubt technologies co-evolve out of interactions in specific contexts. This implies the responsibility to be a collective one for where and how technologies travel and with what use. No innocent position exists. The demand on us as knowledge and technology producers is focused on the direct reality producing consequences of our research and thus put us right into the context of implication.

The frames of understanding are developed within feminist technoscience linked to practitioners and writers of mode 2 knowledge production. How can feminist research as well as other research disciplines taking a critical view of science be able to mobilize the transformatory potential needed?

Part I presents insights into needed relocations in (onto)epistemological infrastructures and Part II a positioning in the fields of feminist research and feminist technoscience. Part III includes experiences and discussions about two political dimensions – research political initiatives to support feminist research followed by reflections on the convergence of science and politics. Part IV offers examples of research in contexts of not only application but implication.

Introduction

My story

When Donna Haraway (Haraway, 2014) is urging us to consider that "it matters what stories tell stories. It matters what thoughts think thoughts", I get words for the core mission of this essay collection

It matters what epistemological frameworks we understand and act in the world with

This essay collection is a piece of academic work converging into a story of distributed knowledge productions within a time frame from the middle of the 80s until present times. I take Haraway's urging seriously and start with my own story as a lens to see how and why I ended up in devoting my academic tryings the way I did. I want my voice to be heard throughout, as the words of my voice are lived through. I am writing experiences from within and not from an innocent, hidden shelf. However, I seldom work alone, which means in some of the chapters there is a sympoietic[1] voice. These other voices so essential for me comes mainly but not solely from my appreciated colleges Elisabeth Gulbrandsen, Birgitta Rydhagen and Peter Okidi Lating.

In a deep and silent forest in Finland I met a well known feminist philosopher in person for the first time. This was at a Nordic doctoral course in 1989[2]. She told us in attendance at least to pronounce the word epistemology. Her name is Sandra Harding. Being a scientist raised in Swedish faculties of natural science and technology my trying key to a constructive and future oriented feminist research within my mother disciplines became at this occasion confirmed.

But something happened before this occasion in Finland.

Four snapshots will illustrate the context, where I began my academic life;

I. I entered my university life in a time window characterized by the aftermath of the student revolution in 1968, Vietnam war, junta in Greece and Chile, reinforced women's movement and an environmental movement focusing the national referendum of nuclear power.

II. I started to study mathematics at Lund University, Sweden. My father wanted to give me an electrical calculator. At that time (1970) the cost of this calculator with only the four basic functions of plus, minus, times and division was 1 000 SEK (about 7 600 SEK 2016 and nowadays worth almost nothing). My farther couldn't afford it. No problem, I used my head and a slide rule in plastic.

[1] collectively produced and linked with

[2] Nordic Research Course in Gender Research specifically focusing interdisciplinary methodology and theory, Littokoti, Veikkola, September 1 – 12, 1989.

III. We, the students in mathematics, learned programming (like Fortran and Algol) by punching hole cards and deliver the paper program cards over desk to the computer hall staff to be executed. No personal computers or internet existed yet.

IV. During my PhD studies there was a professor in organic chemistry, Eberson, with an interest in theory of science. I attended one of his lectures, when he presented Karl Popper, Thomas Kuhn and Paul Feyerabend. He demanded us PhD student to stay close to the falsification method of Popper, which of course made me more curious about Feyerabend. The lecture became for me the first obvious flaw on the positivist upbringing in my scientific training.

During the last years of my PhD studies I found an environment at Lund University open enough for questions and challenges of knowledge production to be thought upon and discussed. The Swedish government had started to support (with very little but important money) academic environments for female researchers and gender research in the end of the 70s. First out to establish such a Forum was Lund University in 1978 (Trojer 2002 p.17). We were very few PhD students from natural science and engineering, but eager to take part in developing gender research perspectives in our own disciplines, which later for me became feminist technoscience[3] .

What I as a scientist started to do, was to unlearn my epistemological position as a positivist[4] . These attempts of unlearning are not an end in itself. It is a necessity, as this knowledge view, which I was raised in, proved too non-functional and limited in the contexts I have placed myself - like natural science and engineering in general, information and communication technology, media technology, environmental issues, relationships between developed and developing countries, survival issues, technology and research policy, emerging innovation system processes. I started a long journey mainly but not only through feminist theory constantly rooted in the natural and engineering sciences. A more substantial discussion about my unlearning process is presented in chapter 1.

After my PhD training and after working with environmental issues in a third world context as well as developing feminist research within natural science and technology, I became associate professor (docent) in feminist technoscience[5] . This signifies crossing some distinct disciplinary borders. Just before the millennium shift I got a professor chair in the subject of information technology and gender research at a Swedish profiled university, Blekinge Institute of Technology (BTH). The profile is applied ICT and sustainable development. When I started at BTH the profile was expressed as applied ICT in close cooperation between the university, government and industry, a profile I prefer being a mode 2[6] researcher.

The stories in this book are told in a reference frame of scholars with a huge influence on my thinking and acting besides from highly valued influences from my daily colleagues in different contexts. Please let me shortly draft the core parts of this frame constituting the thinking floor, upon which I walk.

[3] I use the concept feminist research synonymously with gender research and I use the concept feminist technoscience almost synonymously with gender research within technology and engineering as well as feminist research within technology and engineering. See chapter 5 and 6.

[4] Just to make myself clear, the positivist knowledge view as I have learned to understand it is characterized by objectivity (possible to identify and read off a true reality), neutrality, cumulative knowledge expansion, reproducibility, sharp demarcation between the research subject and research object, between basic research and applied research, between what is considered true and false etc..

[5] The formal naming was Gender and Technology.

[6] See chapter 11.

The inner circle of my reference frame includes

- Carolyn Merchant / the scientific revolution
- Elin Wägner, Flory Gate, Rachel Carson / ecology, ecofeminism
- Vandana Shiva / global perspectives, postcolonialism, ecofeminism, green revolution
- Julia Kristeva / philosophy and semiotics, language and gender theories, postmodernism
- Sandra Harding / epistemologies, the Harding turn i.e. the science question in feminism
- Donna Haraway / my main source of inspiration and motivation e.g. figurations like cyborg and companion species, situated knowledges, worldproducing, God trick, poststructuralism
- Evelyn Fox Keller / knowledge production and its impacts, methodology and theory development intertwined
- Sharon Traweek / knowledge production
- George Henrik von Wright / fragile future
- Helga Nowotny / transdisciplinarity, mode 2, socially robust knowledge
- Michael Gibbons / mode 2, distributed knowledge processes
- Reijo Miettinen / epistemology of transdiscursive terms, national innovation system
- Andrew Feenberg / alternative modernity
- Bruno Latour / research, uncertainty and politics
- Richard Rorty / methodology, solidarity
- Sheila Jasanoff / technologies of humility
- Karen Barad / ontoepistemology, new materialism, agential realism and posthumanism

Introduction continued

My intention with this book is to bring forward discussions on how we as researchers in technoscience are deeply involved in transformation processes through our knowledge production. I want to turn focus to the knowledge production itself, where it is located at our universities and institutes of technology. I'm quite aware of the contemporary situation, where the boundaries between universities, government, industry, public sector and other kind of institutions and societal bodies are exceedingly hazy and changing into complex co-evolving processes or rather involutionary[7] processes. I want to keep the discussion to the role and responsibility of the actors at the universities. I want to bring up the need for (onto)epistemological thinking and awareness in technological transformation processes as far as scientists are concerned.

I agree with the arguments that "modern technology is neither a saviour nor an inflexible iron cage; rather it is a new sort of cultural framework fraught with problems but subject to transformation from *within*" (Feenberg, 1995, my italicizing). With a focus on research transformation interventions we can get in touch with the notions of technology at a late modern time.

[7] See discussions in the epilogue.

(Onto)epistemological thinking and (self)reflexivity in science and engineering is hard to develop. As mentioned above it means for me to go into an unlearning process - to start unlearn my positivist upbringing in the academy, where I've been doing and still am doing my research. Why is that unlearning more than being an intellectual challenge? For me the answer is to be found in a deeper understanding of our role as researchers in close contact with knowledge production and transformation processes, which demand us to think upon the theoretical and methodological fundaments we are using. These fundaments, these epistemological approaches are concrete productive forces. Researchers are part of problems as well as their solutions and the solutions are not always to reactively fix the problems we are causing, but to focus on the fundaments of the phenomena *creating* the problems in the complex of knowledge production. As Haraway states "epistemology is about knowing the difference" (1991, p 161).

What are my prerequisites for reflexivity[8] from *within*? The frames of understanding for me are developed within feminist technoscience linked to practitioners and writers of mode 2[9] knowledge production. To be more precise about my framework, I'm bringing my positivist unlearning forward by using several epistemologies, where poststructuralist strategies are some of the more useful ones. Poststructuralist strategies at expressed by Simonsen (1996) emphasize the relation between reality and representation and are concerned about the understanding of how we create meaning and make sense. The neutrality of science - that is the "seeing everything from nowhere" (Haraway, 1991, p 189) - is substituted by the "view from somewhere", which leads to the argument that science no longer can position itself as universal and clean. No innocent positions exist. My colleague Elisabeth Gulbrandsen use to say that our understandings of reality are limited at the same time as they have reality producing consequences.

To put it in another way using ICT[10] terms - to be a discourse surfer (Stone, 1995) has valuable potentials.

Feminist research within the disciplines of natural science and technology emanates from an identification of local as well as global challenges created within these disciplines. To merely describe the consequences of science and technology (which in itself is an important and extensive task) is not enough, when it comes to achieve the long-term transformations, which is the overarching goal and ambition of feminist research in my understanding. The dilemma we are facing in this work is that science and technology work in practice and do so very effectively in general, while, at the same time, the practical consequences can be rather devastating both locally and globally. How can feminist research as well as other research disciplines taking a critical view of science be able to mobilize the transformatory potential needed? Part II introduces my position in the understanding of feminist research and feminist technoscience.

It seems necessary to expand feminist research by showing how the development of knowledge in science and technology works - how the economic, social and cultural context is directly reflected in theories, formula and software coding that gain acceptance and are preferred in the scientific

[8] I rather use the concept diffraction than reflection, which I come back to in chapter 7. But for the case of not confusing unnecessarily I stick to reflection.

[9] See chapter 11.

[10] Information and Communication Technology

system. If we do not understand and acknowledge these connections, the theories, formula and coding will most likely continue to be apprehended as objective, neutral knowledges and truths. Initiatives aiming at effective change and transformation will consequently be stopped. Additional steps can by taken, and that is to make plain *on what* and *on what grounds* our scientific theories and our technology work. Our systems for production of knowledge and technology seem to answer only to a limited extent the complex situation of our human needs and our vision for the future. Some call this life politics[11] . In a global and ecological perspective, re-thinking and problematizing the validity and serviceability of the knowledge producing system seems to be unavoidable.

The following statements can be seen as part of the reflexivity I wanted to discuss and as a more concrete starting point for discussing self-reflexivity. This central statement can be found in chapter 2, which evolves the issue in more detail.

> *As researchers we not only observe, unveil, analyse and solve problems 'out there'. Our knowledge-producing activities are a (re)productive force whose effect is not contained by the walls of the ivory towers - if they ever were. As researchers we do not have a standpoint outside a civilisation in crises. We are implicated in it. Our knowledge constructions are efficient. They produce 'reality'. They produce chances of life and death and distribute the chances unequally. This fundamental tenet of all research is - as Evelyn Keller (1992, p 9) puts it: "nowhere more dramatically in evidence than in the successes of nuclear physics and molecular biology, that is, in the production of technologies of life and death".*

Accordingly, in science and technoscience we are deeply involved in production of realities for ourselves and for others - not the least in the converging information technology, gene- and biotechnology, nanotechnology, which become closer and closer integrated in our daily lives. In technoscientific contexts our reality producing research meets us as soon as we open our eyes. It is in this context relatively easy to bring up the technoscience question in the agenda of feminist research. I am trying hard to practice the "turn" formulated by Sandra Harding (1986) from the women's question in science to the technoscientific question in feminism.

Donna Haraway and Bruno Latour reject the sharp separation of value and fact in modern thought and treat technology as relative to a framework of social and cultural practices. Technology no longer exemplifies pure rationality. Andrew Feenberg (1995) states "modern technologies open not only possibilities internal to the particular world they shape but metapossibilities corresponding to other worlds they can be transformed to serve. Technical change is not simply progress or regress along the continuum so far traced out by the West; it may also come to include movement between different continua…..Only if we can concretize the issue on the technical terrain will that transition (change) succeed. Only then will we find out what it really means to live and create in a technical society." I appreciate Feenberg's wish to situate issues of transformation *within* the technical terrain, within technoscience, which brings me back to one of my urgings for feminist researchers to be located *within* the complex of technoscience. This is a central condition for feminist technoscience

[11] see e.g. Elisabeth Gulbrandsen (2000).

to be relevant and used at faculties of technology and engineering. Karen Barad has fostered this argument. She writes (Barad 2003, p. 828) that *on an agential realist account of technoscientific practices, the "knower" does not stand in a relation of absolute externality to the natural world being investigated—there is no such exterior observational point.*

I want to stress that we live in a world becoming increasingly dependent and based on techno-scientific knowledge production, that is research and society are in a multifarious way integrated in each other (here is my unlearning process still going on, that's why I have to state this self evident points). No strict boarders any more, if they ever were. Research and politics is more or less impossible to separate. This issue is discussed in Part III. The former Swedish Minister of Education and Research, Carl Tham, raised a vital technopolitical issue in his speech "Research - the key of the future?", in which he emphasized our ambivalence to science and technology, the general oscillation between techno-optimism and techno-pessimism marking the 20th century. Carl Tham started from a position of an explicit division between science and politics. He then turned the discussion around and stated that "Science / technology is ruled by; the male dominated research community in the industrialised world, the market in the industrialised world and the political system in the industrialised world". The Minister ended his discussion by asking questions about the political content of research indicating a shift in the focus of the arguments, which is central from the perspective of feminist research.

It is not by chance Carl Tham put the research political questions the way he did, keeping in mind him being the former director general of The Swedish Agency for International Development Cooperation, Sida. The relevance of knowledge production and the role of universities are brought out in full relief in contexts of low income countries. Human needs and survival get in sharp focus. This is not the least the case within the field of information and communication technology and how to deal with the digital divide, which African mates want to rephrase to digital solidarity.

I explicitly experience increasingly open systems for knowledge production and technology development in my own work in Sweden, East Africa and Bolivia. The demand on us as knowledge producers is focused on the direct reality producing consequences of our research and thus put us right into the context of implication. As a result the praxis of emerging innovation systems - not only placed in a market economical context but in broader societal context – has caught my interest as considered in Part IV and which keeps me to the fundaments of trust and relevance in society.

To summarize - Part I presents insights into how I have relocated myself in (onto)epistemological infrastructures. In Part II I position myself in the fields of feminist research and feminist technoscience. Part III includes experiences and discussions about two political dimensions – research political initiatives to support feminist research followed by reflections on the convergence of science and politics. Part IV offers examples of research as a political arena i.e. research in contexts of not only application but implication.

Part I

Fundaments for Societal Relevance and Trust

How is it possible to pursue an academic work, which in its nature requires that learned trues, theories and methodological approaches are questioned? This challenging ambition doesnâ€™t arise as an end in itself but is emerging in my choices to work in different contexts and functions. To be relevant in both the faculty areas I belong to and in increasingly distributed forms of cooperation may seem to be an obvious statement. But the conditions for academic relevance and societal relevance are different. It became particularly clear to me in the research politic work, which I became involved in during the 90s. The different conditions are also a common experience for many feminist researchers and interdisciplinary researchers. Societal relevance and trust are key words for me, which brought me very quickly to go into problematizing the fundaments of science i.e. ontoepistemological (Barad 2007) bases of science. I ended up in the work of touching the raw nerves of the dominant academic discourse.

Chapter 1

This first chapter forms a history, upon which I tell other histories as well as a start of my travel into trying transformations in my academic contexts. It is an early text, where I use my experiences as researcher in chemistry[12].

Clean and Unclean Facts - Diffractions[13] in Knowledge Production

I am a feminist and a researcher. I have received the traditional research training in faculties of natural science and technology . I have been trained never to write "I" in a scientific text, only to write we, if the use of third person is not possible. The cherished objectivity permeated my thoughts, words and my experimental research work until a professor of organic chemistry gave a lecture on the ideas of some, in his mind crazy, scientific thinkers. This was my first encounter with Popper, Kuhn and Feyerabend. The concept of objectivity got a first blow.

Basic and / or applied research

The dichotomy basic research and applied research is still a popular concept within the field of natural science. The status of each has altered according to the shifts in the wind of research politics. However, despite these shifts basic research, read natural science, has not actually been moved from its position in the hierarchy of science. The notion of a pure science is deeply rooted in the positivist tradition of science, its roots going back to the renaissance and to the very birth of modern science (Merchant 1980). "Impure" research would thus be applied research, usually meaning technology or engineering (Keller 1992 p 78). Since "impure" research is considered to be carried out closer to people's everyday lives and thereby closer to the decisions concerning people's everyday lives, there is a tendency to shift the responsibility for the production of knowledge from basic research to applied research, and even to externalize the responsibility by moving it to the political and social arena. This is completely in line with the predominant tradition of knowledge production and with a mindset characterized by strict linearity.

Nina Lykke[14] brings up a discussion about the potential of interdisciplinary research, in which she makes use of Bruno Latour's description of modernism (Lykke 1994). Modernism is to Latour an act of purification serving to clearly mark off the academic faculties from hybrid forms, which even

[12] This is a revised version of a text first published in Swedish in Häften för KRITISKA STUDIER, nr 4, 1995, (Trojer 1995a).

[13] Diffraction see Haraway, 1997b, p 16.

[14] The discussion referred took place in a plenary session at the conference "Between Mother Goddesses, Monsters and Cyborgs - feminist critique of science, technology and health care", Odense University, Denmark, 2 - 5 November, 1994. See also Lykke & Braidotti (1996).

can consist of elements external to science. In a complex world dependent on scientific knowledge, this zeal for purity is becoming increasingly difficult to satisfy, especially in natural science and technology.

Scientific production of knowledge has, for a long time, moved towards an increasing dependency on advanced technology. Technology in the form of research equipment is supposed to exist for the purpose of making visible the things we cannot perceive directly with our senses. My own field for PhD studies, analytical chemistry, is like most other fields within natural science shaped by instrumental, technical methodology. Wet chemistry methods, which are possible to separate from advanced technical know-how within analytical chemistry, are more or less history or automatized parts of the construction of technical equipment. Applied research in the form of advanced technology is integrated in basic research. The borders between natural science and technology are being erased. The two have instead become the prerequisites of each other's existence[15] .

The development within molecular biology proves that basic research and technology can be totally coincident. As soon as you by means of your active substances achieve a successful experiment in the test-tubes, you have simultaneously created a concrete genetic method (and product). The applied research, technology, here is for obvious reasons shifted to further full scale production of the product. To sum up the dichotomy basic research and applied research has exceedingly hazy boarders.

Theory and method

The assertion that all methods are "impregnated with theory" has for long been notified within the social sciences (Lindholm 1989). The relevance of this understanding in natural science is not far fetched. Since most methods are instrumental, the consequence of the line of thought mentioned is that the theories we develop / create / produce have the same natural scientific foundation as the instruments we are using to form the basis of our theories. We can thus never locate ourselves, objectively and neutrally, on the side of our natural scientific research objects. Sandra Harding points out (Harding 1993, p. 16-17) that scientists never can observe trees, rocks, planetary orbits or electrons in a state, in which they are untouched by human activities or meanings. Instead, they are destined to observe something different but, hopefully, systematically related to nature apart from human perceptions: nature-as-an-object-of-knowledge. The Heisenberg uncertainty principle is another illustration, which has profound implications for such fundamental notions as causality and the determination of the future behaviour of an atomic particle. Karen Barad continues this kind of discussion (see below). There is a "vicious circle" in the forming of theories, also in natural science. Our methods are with other words also "impregnated by theory". This is a thought that scientists within "pure" natural science are very unaccustomed to[16]. The impacts of bringing Donna Haraway's idea of "situated knowledge" straight into the world of chemistry and physics with its

[15] This development also contributes to the use of technoscience as a disciplinary concept.

[16] A more detailed discussion will be found in for instance (Keller 1992).

formula fixation are still a true challenge[17]. If natural science would live up to its absolutely neutral ideals - also when it comes to methods - we would be compelled to place ourselves outside of the prevailing paradigm of natural science. Just the thought is a preposterousness. What I call for in natural science is a degree of humbleness in our claims of absolute knowledge. If self reflection could be developed and practiced within the natural scientific and technological disciplines, many of the problems that feminist research pay attention to would be addressed in a more appropriate way.

Sharon Traweek has in her book Beamtimes and Lifetimes (Traweek 1988) given an initiated picture of production of knowledge within high-energy physics. Her work was based on a study of three national accelerator laboratories; SLAC (Stanford Linear Accelerator, USA); KEK (Ko-Enerugie butsurigaku Kenkyusho, Japan) and Fermilab (Fermi National Accelerator Laboratory, USA). Experiments within high-energy physics are constantly dependent on instrumental innovations, especially when it comes to detectors. There was a special detector attached to every experimental research team within the laboratories mentioned. The different detectors represented different views of knowledge and different methods.

> *The differences among these detectors serve as a mnemonic device for thinking about the various groups' models for scientific method: how to elicit traces from nature that are both significant and reproducible. Detectors themselves, then, supply a system for classifying modes of discovery. Each is the material embodiment of a research group's version of how to produce and reproduce fine physics, how to gain a place for the group's work in the taxonomy of established knowledge.* (Traweek 1988 p 72)

The contrasting approaches of the stationary research teams and visiting user groups (for the detectors) at SLAC made the stationary teams' view of knowledge production visible. The stationary team held the opinion that the knowledge of the head should have an equivalence in the practical skills of the hand. To know your detector inside out and thereby be able to use and manipulate it yourself, was / is a prerequisite of good physical research. At KEK in Japan, the situation with the detectors was completely different. The Japanese research teams were entirely dependent on commercial instrument developers. The process of production of knowledge was in this case an entirely different one. How this was reflected in the forming of theory is hard to tell, since KEK at the time Traweek's study was carried out was in the process of being built up. Traweek was however able to see that KEK's detector was designed to minimize noise, which is a fact that reduces the possibilities of finding new data. Research qualities of different kind occurred.

The instrumental development of methods has been enormous during the last decades, mostly due to the computerization of systems. I was a postgraduate research student in the field of analytic chemistry during the second half of the 1970s. My research was concentrated on development of instrumental techniques and I worked both within the faculty of technology and the faculty

[17] Donna Haraway, with her background in natural science and biology, describes a knowledge process focusing "what we learn how to see", like in the text "Situated knowledges: The Science Question in Feminism and the Privilege of Partial Perspective" (Haraway 1991b, pp 183-201). She writes "Feminist objectivity is about limited location and situated knowledge, not about transcendence and splitting of subject and object. In this way we might become answerable for what we learn how to see."

of natural science. The technical analytical chemistry at the technical institute and the analytical chemistry at the university in the same town were closely linked. This is a case where we can talk about hazy borders between "pure" and "impure" research.

The chromatograph instruments I worked with were usually not steered by a central processing unit in those days. For this reason, I gained a lot of practical skill. I learned how to adjust most of the parts of the instrument myself, from the place of injection to the detector part. The practical skills of my hands, reduced the distance to my research object (high-molecular materials). It was hard enough to be forced to have a "box" between myself and the research object. To have a "box" plus a technician between myself and the object I wanted to study, creates even more distance. The more computerized the instruments becomes, the less able is the individual researcher to her / himself influence the instrumental method. What we have gained in precision, time and possibilities, we have partly lost in dependence (to the instrument company). The effects of these factors are hard to judge, since it is problematic to generalize and because we here touch upon our epistemological preferences. Almost ten years after I formulated myself like this, Karen Barad excellently expressed what I have tried to do. She states *They (apparatuses) are neither neutral probes of the natural world nor structures that deterministically impose some particular outcome….apparatuses are themselves phenomena…Apparatuses are constituted through particular practices that are perpetually open to rearrangements, rearticulations and other reworkings. This is part of the creativity and difficulty of doing science: getting the instrumentation to work in a particular way for a particular purpose….Apparatuses are material (re)configurings / discursive practices that produce material phenomena in their discursively differentiated becoming* (Barad 2003 p 816, 817, 820).

To the experimental physics within high-energy physics, detectors were no pre-programmed black boxes (Traweek 1988 p 49). Traweek states that the physicists saw the development of these instruments as a part of discovering nature (in their vocabulary). The detailed description Traweek gives of the relationship between the constant building of detectors and the process of knowledge production provides a possibility to challenge the traditional belief in a mechanistic way of establishing facts i.e. the context of discovery.

Quantitative methods

After I had finished my undergraduate studies, I worked as a laboratory assistant in a research laboratory for a year. I performed nitrite analyses by using cadmium reductors and making potentiometric measurements. My job was to achieve nice looking, straight calibration lines. Every now and then the values jumped out of the wished-for line. My task then became a matter of carrying out as many experiments as was needed in order to drown the anomalies in the statistic material.

The philosopher Richard Rorty reflects in a frank way my experiences in the following thoughts on the question of method:

> *Within what Thomas Kuhn calls the "normal science"-puzzle-solving - they (the scientists) use the same banal and obvious methods all of us use in everyday human activity.*

> *They check off examples against criteria; they fudge the counterexamples enough to avoid the need for new methods; they try out various guesses, formulated within the current jargon in hope of coming up with something which will cover the unfudgeable cases… Scientific method means… obeying the normal conventions of your discipline, not fudging the data too much, not letting your hopes and fears influence your conclusions unless those hopes and fears are shared by those who are in the same line of work.* (Rorty 1981)

There are great temptations in statistic analysis of results. Gregor Mendel, the monk and one of the greatest innovators in modern biology, formulated theories of heredity on basis of a statistic material from experiments with leguminous plants. His many years of laborious research-work earned him the recognition of being the founder of genetics. There have been a number of thorough investigations of Medel's methods, as his results have proved to be difficult to reproduce. Already in the 1930s, the statistician Ronald A Fisher showed that Mendel had chosen data selectively in order to get the best numerals. In 1966, the geneticist Sewell Wright suggested another explanation in a short but often quoted analysis - that Mendel's one and only error might have been an innocent tendency to count wrong in favour of the expected results, when he counted the hereditary qualities of his peas (Broad & Wade 1983). I assume a hesitant attitude to whether the ethics in scientific methods have improved since the end of the 1960s, when B L van der Waerden expressed the following opinion in a discussion about Mendel's selection of data:

> *I have the feeling that many perfectly honest researchers would tend to follow a mode of procedure as such. As soon as you have got out a number of results that clearly confirms a new theory, you would publish these results and put the hesitant cases to the side.* (Broad & Wade 1983 p. 40, translated from Swedish).

It is easy to feel upset about the manipulating tendencies and lack of honesty of researchers. These problems with quantitative methods bring about serious consequences, which we for instance can observe in theories about women's bodily and mentally functions based on hormone and brain research[18]. It does not seem to be sufficient to improve the statistic method for dealing with the problems. The question is if we in this matter should not turn our attention in an alternative direction and problematize the statistic methods as such. One of the more obvious examples of this approach is Barbara McClintock's understanding of epistemology and its consequences in experimental research work, an achievement for which she was awarded the Nobel price in medicine. Barbara McClintock, who was a geneticist, strongly questioned the statistic analysis of results. Her main source of knowledge was the anomalies in the material. She was of the opinion that the great challenge to researchers within most disciplines is to liberate themselves from the hypotheses / theories, which they have established all too soon. McClintock disapproved of the fact that many researchers already have a ready-made answer, before the experimental work is completed. *This makes them uninterested in anomalies and in the knowledge inherent in anomalies* (cited in Keller 1983).

[18] Ruth Bleier gives in her books and other texts comprehensive arguments, see Science and Gender: A Critique of Biology and Its Theories on Women (1984) and Feminist Approaches to Science (1986).

If the case is to eliminate results in form of anomalies, which can not be explained by experimental errors such as errors in preparation, instruments, wrong reading etc. and which might carry vital knowledge - then we ought to make sure that the failed results are published to the same extent as the successful ones. This idea has been discussed within science, but it seems to be very difficult to carry it into effect, for the reason that legitimacy within the academy is created by the publishing of successful results and nice-looking, concentrated and clear formulas and theories (Trojer 1994). However, if failed results would be published to a greater extent, it would in reality contribute to the credibility and clarity of "successful" results, since these, as I have explained above, may be more or less censored or limited.

Extrapolation

The straight lines are desirable and practical. I have problematized the creation of these within natural science. I am now passing on to a discussion about the potential for extrapolation of the straight lines and the meaning assigned to this.

The example - however simple - I have chosen is about gases and how they work. Gases consist of molecules, which move in relatiovely free and irregular ways. It was probably with that feeling and that apprehension van Helmot, in the beginning of the 17th century, created the word "gas" as a formation of the word "chaos" (Hägg 1963 p. 39).

The general law of gas shows a linear relationship in the ideal gas equation

$$PV = nRT$$

where P=pressure, V=volume, n=moles of gas, R=gas constant, T=temperature in degrees Kelvin.

We can obtain a straight line in an honest way, if the temperature is not too low, the pressure not to high and the gases that are used are inert gases, hydrogen, nitrogen or oxygen. The general law of gas applies to, so called, ideal gases - imaginary gases, whose molecules behave in such a way that no forces interact between them except when they collide, and the total volume of the molecules can be neglected compared to the volume of the vessel in which the gas is enclosed. At a pressure of up to 10 atm and at zero degrees Celsius, the gases mentioned behave almost like ideal gases. At low temperatures, high pressure and with troublesome gases, it is not possible to get a straight line. Ideal gas calculations can for instance be used to determine the molecular weight of different substances. Where there can not be absolute, ideal conditions, you perform pressure measurements of pair of gases and extrapolate to the value for the pressure 10 atm, where the gases are said to behave as ideal gases.

By this example, I want to show that natural scientific theories can be a result of a more or less distressed adjustment of a complex reality to a simplified theory. In most cases the theories function well within the selected fields of application. But the awareness of the limitations of the theories is often not clearly expressed or discussed - which is one way to reproduce the myth of absolute truth. Carita Peltonen shows a conspicuous extrapolation in her reflections upon the Schrödinger

equation for quantum mechanical interpretations of atomic physics. This advanced theory is based on the simplest element of all - hydrogen, which is the only gas for which the differential equations of theory can be solved[19].

GUTs

We can observe that there is a striving within natural science to expand the validity of theories beyond areas and conditions that are empirically proved. One example in physics is the efforts of getting closer to a Grand Unified Theory (GUT), which was first coined in 1978 by researchers at CERN[20]. The goal seems to be as few comprehensive theories and formulas as possible. These are to be generalized to such an extent that most phenomena can be derived from them.

Traweek described the development of GUT in 1988 in the following way:

> *Eventually gauge of the strong force and the electroweak force were combined into a GUT. Theoretical efforts are now under way to incorporate gravity with a GUT, and these are called "superstrings theories". Physicists are also trying to incorporate superstring theories and supersymmetry into a "Super GUT". The proposed research device known as Superconducting Super Collider (SSC) is justified as necessary to investigate these new theories.* (Traweek 1988 p 48)

This research laboratory for the desired GUT was estimated at a cost of 88 billion SEK[21] and was to be built in Texas. The American Congress stopped this investment. Other fields of knowledge were given priority. The research political interest was turned towards the field of biotechnology, which was made plain, not least at UN's conference on environment and development of that time, in Rio de Janeiro in 1992.

Still the striving for unifying theories as GUTs seems to prevail. In 2012, all GUT models, which aim to be realistic, were quite complicated because they needed to introduce additional interactions, or even additional dimensions of space. Due to this difficulty, and due to the lack of any observed effect of grand unification so far, there is no generally accepted GUT model[22].

To reduce reality to general laws and theories, as concentrated, compact and minimized as possible, is to draw close to the highest ideals within natural science. Physicists above all but also chemists and mathematicians sometimes grow lyrical, when they talk about theories and formulas, which, in their "elegant", minimal form comprise wide knowledge. The fascination among researchers and the public for the theoretic physicist Stephen Hawking's cosmological work and efforts towards advanced, reduced theories for the initial state of the Universe confirms the ideals mentioned above (e.g. Hawking 1980). The complex reality we can experience even in the smallest of ecosystems,

[19] The reference is from the lecture of Carita Peltonens at Nordic Forum, Åbo, Finland, August 1994.

[20] The European Organization for Nuclear Research, Geneva. At CERN physicists and engineers are probing the fundamental structure of the universe.

[21] Svenska Dagbladet (The national newspaper Swedish Daily) 1994 04 08

[22] Wikipedia retrieved 20160418.

easily leads to something very different from this ideal. A modified start with a holistic perspective of the complex system to be studied followed by complete focus on the different parts of the system, does neither seem to satisfy a relevant view of knowledge for complex systems.

Knowledge as vectors

What does the statement of close connections between theory, technique and consequences mean? I have argued the relationship between theory and technique to be a question of mutual dependency, of one being a prerequisite of the other. A dividing line between theory and technique is a construction that has been built for distinct reasons.

Keller confirms that different contexts "write themselves into" the theories (Keller 1992). The content of a context may of course be highly dependent on the consequences of production of knowledge. We thus get a feedback of consequences in the further development or innovation of theories. This can be illustrated by the way the Western World formed theories within agricultural research in the so called Green Revolution (Shiva 1991).

The great number of linked contexts makes it increasingly difficult to view the production of theories as an activity without inherent driving forces and potentials to guide itself in non-accidental directions. Keller describes the traditional view of the direction of knowledge in this way:

> *Scientists work to increase our fund of knowledge of the neutral world as they must, for sooner or later, knowledge will out. Knowledge... can be thought of as an expanding sphere of light in a background of darkness. Its only directionality is outward; it just grows, without direction, and without aim.* (Keller 1992 p 81)

The understanding of the results of basic research in natural science involving a development in a particular, non-accidental direction and a particular technological development with specific consequences is increasing within feminist research. Why this understanding is growing within fields of feminist research has its explanations in the necessity of a complex theoretical understanding of the scientific projects of transformation, which are the goals of this scientific work[23].

Corlann Gee Bush (1983) identifies the inherent potential in all technology of taking particular routes. She emphasizes the use of a particular technique to be not only determined by political decisions or by the individual user. There is an inherent "vector function" in the technique itself. An obvious example is the comparison between the use of a rifle and a screwdriver.

Evelyn Fox Keller is even clearer in her view of an inherent force and direction in knowledge. The following quotation formulates a couple of questions of importance for me:

> *To be sure, instrumental knowledge has force in the world, but force, as we learned in freshman physics, is a vector. It has not only magnitude, but directionality as well. And*

[23] This aim has become such a self evident project that it has not been an object of problematizing in a visible way. It seems like feminist research now has reached a point where the self evident project more or less collapse. (Trojer & Gulbrandsen 1996).

> *if we grant directionality to the force of scientific knowledge, then the obvious question arises: In what other direction might science work? Toward what other aims?* (Keller 1992 pp 74, 75)

Research and implicit power

This chapter is an attempt to draw close to scientific forming of theory. This early aim of mine has been to problematize the notion of objectivity from feminist research perspectives in order to contribute to the understanding of the connections in my main point, that the bonds between (the forming of) theory, (the development of) technology and consequences are strong and interlaced without beginning or end. Feminist research as it evolves integrated in technoscientific contexts and located in transdisciplinary cooperation is a framework of understanding. This framework is now and then accused of being results of political pseudo research (Ehrenberg 1994). When these situations occur either in the research complex or in the research political system in Sweden, it is noteworthy to recognize how feminist research brings up to surface the political content of all research activities and triggers the sensibility of keeping that hidden. I have realized how difficult it is to gain a hearing for this understanding, since this field of research steps right into the discourse of technoscientific knowledge production and makes well hidden relations of power and privileges visible.

Chapter 2

This chapter represents a piece of work fundamental to my academic life, which during many years has included a close cooperation and friendship with my colleague Elisabeth Gulbrandsen and still do. I am most grateful to Elisabeth for letting me include this text in the book. What we have written here has been an important, mutual understanding for our efforts of trying transformations in our respectively daily academic and research policy contexts.

Authority in Transformation[24]

> *... the declining authority of the West to determine how the rest of the world shall live requires a rethinking of the past, present and future of Western sciences and their technologies no less than of other important Western institutions and practices.* (Sandra Harding 1993)

Introduction

The following comes out of an interdisciplinary discussion through which we want to spell out some challenges to ourselves as researchers and feminists adequate to our Nordic contexts. It is not a presentation of already done, neatly wrapped up research. As part and parcel of neatly wrapped up research often comes an effect of "othering", of (dis)placing both problems and challenges with others. A certain understanding of self (however brittle) is also induced or effected while wrapping up is on the agenda. As we peer under the veil to discover or reveal hidden meaning, provide expertise or counter-expertise, we easily slide into understanding our role as "helping the suffering people out there". As researchers we are part of the solution: "... developing at home that voice of entitlement, the voice of control, that accompanies the conquest of empires far from home" (Traweek 1992, p 461)[25].

We argue that it is high time we make a shift. A shift that may seem simple, but as our own "trying transformations" tell us; it is certainly not easy[26]. Time is ripe for us as partakers in the modern research complexes, to develop a *readiness* to think and feel ourselves as part of the problem, and

[24] This text is a revised version written by Elisabeth Gulbrandsen and Lena Trojer first published in Trojer & Gulbrandsen (1996).

[25] We take such an understanding to be fairly widespread in Nordic women's research implicating we "in here" have developed something valuable we want to give to you "out there". At a Nordic conference on "Women, Development and Environment" in Oslo (autumn 1990) the Indian feminist/activist/researcher Vandana Shiva responded to our wanting to export our knowledge to Indian rural women, by asking back "Who appointed you God?"

[26] We refer here to an article "Trying Transformations" (Aiken et.al 1987) that has meant a lot to us in so far as it was the first attempt to make sense of transformatory work from inside the established institutions, that we met. This article and the accompanying book; Changing Our Minds (Aiken et al 1988), is still one of a handful of texts that we find has potential to enhance our "transformatory competence". We find this worrying. Please tell us, if you know of other examples!

learn how to use our implicatedness as resources for transformatory projects. This shift represents our "headline" challenge. This chapter aim to expand on this challenge by spelling out some of the motivations for and implications of the shift, as well as pointing to conditions for carrying it through.

Context

From the very beginning, the new gender research[27] holds a science critique programme[28]. What motivated the researchers were lacks and biases in established research. In spite of continuous struggles to transform, we have not found discussions of feminist research as a *movement for transformation of science* in Nordic feminist literature. We miss discussions of how we work in order to induce change in the knowledge producing apparatuses we so intimately inhabit. Mostly it is substantial results of research that are presented, when the status is settled. To employ a familiar metaphor, we are given new maps, and few, if any, references to the construction of the maps are included. A narrow understanding of knowledge production as impelled solely by science's own internal logic is implicitly conveyed. A similarly naive understanding of how transformation or change is effected is supported.

This emphasis on developing knowledge about transformation of science we find as relevant in a Nordic context as in an international context. The Nordic circumstances put this clearly on the agenda as the stated ambitions to change or transform the sciences are high in Nordic feminist research. An often employed term is "revolution". But are the means to accomplish such revolutionary transformations correspondingly developed? One example from the Centre for Women's Research at the University of Oslo may indicate existed reflections on transformation. Results of the first centre-initiated research project (Taksdal, Widerberg, 1992) represented a relatively huge commitment, including a research course for all social science disciplines. We read the book as a central text for discussing the new gender research in Norway. Summing up the project and the course, the editors (head of research and her assistant) state:

> *We cannot imagine that it will be possible to discuss 'kjønn' [in Norwegian there is just one word 'kjønn', not conveying the sex/gender distinction] in the same old way after the publication of this book, and we see before us the revolution in the understandings of disciplines that has to follow in its wake. That is, when we think logically and intellectually. Our academic experiences tell us, nevertheless, that the resistance to the development of knowledge regarding understandings of 'kjønn' is not located at the intellectual level, but at the emotional. It is about 'kjønn'....* (Taksdal and Widerberg, 1992: 282; our translation)

The ambition is revolutionary, and the writers admit not having a clue about how to bring that revolution forward, after the breakdown of the belief in the force of the "best" arguments. Hindrances

[27] We are aware that some would prefer the term "feminist research" as a translation of the Nordic word "kvinnoforskning" (women's research). We suggest that the term "feminist" is applied, when discussions about what we mean by feminism and about the evaluative frameworks different feminisms can yield are included both in the research activity and in the presentation of results.

[28] By "science" we mean what is referred to in Norwegian by "vitenskap", Swedish "vetenskap" and in German by "Wissenschaft", all of which includes not only the natural sciences, but the social sciences as well as the arts and humanities.

are located at the "emotional level", and as such they are out of reach, even though this is admitted as a repeated experience. The dreaded "othering process" is also at work while naming "gender researchers" as the ones who "think logically and intellectually". From this no transformatory competence can be recognised.

The centres for gender research in the Nordic countries are small and vulnerable with a correspondingly strong need for legitimacy. What renders legitimacy to the products of feminist research in a non-feminist world, are not always what is helpful for developing transformatory projects. Such projects require that we open up for scrutiny and discussion of problems and challenges that often are cleansed out of texts in order for them to pass as authoritative. If we do not keep our justificatory struggles separate from the transformatory ones, the impact may be a naive thinking about transformation and/or a slide into conventional science that "means a treachery against the great, long range, feminist science projects" (Kaul 1993, p 154). Accounts of "feminist research as professional academic work" (Steinfeld 1993, p 25) and warnings against "galloping amateurs in feminist research"[29] give added force to such slides, when issued by persons in power. A transformative competence must include continuous explications and problematizations of criteria for evaluating research, and not to give the impression that we all know and agree about them.

We assume that feminist researchers in the Nordic countries have special prerequisites for developing transformative competences. As we have had women in power positions for so long, it becomes increasingly harder to assume that once women enter positions, change or transformation automatically happens. In the Nordic countries we have hold the world record in women representatives in our national assemblies. In spite of this high representation alternative politics is hard to discern even in sectors that are said to be of special relevance to women like child care, care of the elderly, medical care and other welfare issues (Skjeie 1991). Accordingly, we expect a high recognition of the need to expand on, discuss and complicate our transformatory struggles in science and society. All our different "trying transformations" will provide us with ample material.

What we maintain and will spell out as best as we can in the following, are the need and the challenge for feminist research to broaden its understanding of processes of knowledge and learning as an additional prerequisite for the unfolding and evolving of our transformatory competence.

Crisis? What crisis?

Why can't we be satisfied with substantial reports and new maps like "Forståelser av kjønn" (Taksdal, Widerberg, 1992)? Why is it so important to us to try and mobilise for development of transformative competence? That has to do with our assessment of the situation we are in, or better, have brought ourselves into. We also find it necessary to consider whether a developed transformative competence can turn out to be what renders legitimacy and accordingly authority to feminist research in the *longer* run.

The global environmental and developmental crises make heavy demands on the modern research complex's capacity for renewal and adjustment. Enhanced understanding of resistance against and

[29] Warning issued at a Nordic conference for science policy in feminist research. Hässelby slott, November 1993.

possibilities *for* transformation, is coming up as a competence much sought for. Norway may again serve as an example. A relatively strong commitment, included monetary support, to research guided by an environmental awareness goes together with being the land not only of the midnight sun but also of the Brundtland report[30]. After several decades of recognition of environmental and developmental crises, in grass root movements and on political arenas as well as in the research complex, after relatively heavy funding of research on these problems and of research programs for alternative futures, Norwegian research and research politics is marked by distress and frustration. Strong voices maintain that the research transforming movement that is needed to meet these challenges has proved too difficult to set in motion. Interdisciplinary research was early singled out as one of the most crucial challenges. More than twenty years after the Brundtland report one of the participants at a summing up conference on research and research policies in environment and development in Norway, characterised these efforts as amounting to pouring "the same old wine on bottles with new labels"[31]. What hinders our realising such sensible ambitions?

His-story only - or new alliances?

At times it seems to us that we are trudging in fine programs from the 60s and 70s with little or no transformatory power. We have come to fear that this impotence is inherited by the relatively new field of "science studies" as well as by Nordic feminist research. Nordic feminist research share transformatory or revolutionary ambitions with the science critique programs often presented as its forerunners, with critical theory and critical hermeneutics (Iversen 1982). A claim possible to connect to such traditions is that there are intimate connections between knowledge producing processes and social and cultural interests. The ideal was formulated as a "critical theory". A theory was critical in proportion to its ability to specify its own (pre)conditions. What could be struggled for, was a relative objectivity, an objectivity that could specify its own borders, which also indicated a theory's possibilities, even if this point seldom was underwritten in the discussions in the 60s and 70s. The same explicit ambition to recognise research developing in contexts, and that different historical, cultural and social relations saturate the product of research, motivates Sandra Harding's work with "strong objectivity" (Harding 1991), Donna Haraway's "situated knowledges" (Haraway 1988) as well as Rosi Braidotti's struggle to develop what she conceptualises as "critical feminist theory/epistemology" (Braidotti 1991).

In spite of such fine ambitions and ideals existing in Norway for more than 50 years[32], the consequences of the understanding are never drawn in so much as the researcher explicitly reflects his point of departure or his role in the research process into the product. The proliferation of statements like "I am a white, heterosexual, middle class feminist ….." in prefaces and talks, has made us suspect a certain inheritance of this impotence in feminist research. We read such statements as

[30] Our Common Future, From One Earth to One World - An Overview by the World Commission on Environment and Development, UN document http://www.un-documents.net/our-common-future.pdf Forward Chairperson Gro Harlem Brundtland, Oslo, 20 March 1987.

[31] The conference was marked by a humble attitude as well as confessions of doubts and defeats. A report was published by the Council for Social Science Research in the Norwegian Research Council for Science and the Humanities, titled Miljö og utvikling, Rapport fra den forskningspolitiske konferensen på Vettre, 28 - 29 januar 1992. (Environment and Development: Report from the conference on research policies at Vettre, January 28 - 29, 1992).

[32] The Norwegian philosopher Hans Skjervheim was an excellent mediator who also expanded on these critical traditions. One of his most influential texts circulated as a working paper from the late 50s and thus prepared the Norwegian student revolution.

a symptom that a critical challenge still has to be met: How do we work in order to move from the claim that "science is in society and society is in science" to be able to say something about how this moulds the product?

Continuities between the critical programmes of the 50s, 60s and 70s and the relatively new field of "science studies" can easily be traced. (Børmark 1984, Elzinga 1988, Lundstøl 1977). Science studies have produced heaps of historical, sociological, anthropological and science policy texts motivated by an understanding of science as a context dependent process. This work has localised science in social/historical/cultural relations, but have to a much lesser degree - if at all - managed to develop grips on "internal workings" conventionally understood. To become aware of how "society (works) in science" seems to represent a greater challenge than to trace how "science (works) in society".

In 1985 Evelyn Keller summed up this situation: "Yet, while our sensitivity to the influence of social and political forces has certainly grown, our understanding of their actual impact on the production of scientific theory has not" (Keller 1985, p 5). The lack of mediations between the relatively new external perspectives and older, more internally based analyses has grave consequences regarding our possibility to develop a transformative competence as researchers. As a result of this lack, we cannot but regard science's products as being impelled solely by science own internal logic. In the everyday life of doing research, we are left without possibilities to understand how macro powers are at play, we are left without the possibility to consciously act and transform research in a direction of our own choice.

In a Nordic context, concessions are made that the ambitions from the 60s and 70s have as yet to be realised. (Gregersen, Køppe 1985, Håkanson 1988, Kjørup 1985, Rosenbeck 1992, Lundgren 1993). A bit of work has to be done before processes of knowledge and learning can be more consciously mediated. In this situation we - as researchers - are left with judging only the consequences of what we partake in creating modern science and technology. We have not developed the means to act and transform while we are "at it", while we are producing science and technical solutions. The chances are high that we will only be prepared to act in a chosen direction, when it is too late. Challenges from the global environmental and developmental crises, cannot be adequately met, before such mediations are realised.

Implicatedness as resource

If the diagnosis we have hinted at above, are accepted, this impotence becomes an acute problem. Challenges arising from indications that the ecological and poverty crises are intimately linked to our Western ways of living are addressed at the self-understanding of the actors in the modern research complex. As participants in this complex we can no longer see ourselves only as deliverers of solutions, as helpers. We must also see ourselves as part of the problem, and we must learn how to employ our implicatedness as resources for our transformatory projects.

As researchers we not only observe, unveil, analyse and solve problems "out there". Our knowledge-producing activities are a (re)productive force whose effect is not contained by the walls of the ivory towers - if they ever were. As researchers we do not have a standpoint outside a civilisation in crises. We are implicated in it. Our knowledge-constructions are efficient. They produce "reality". They

produce chances of life and death and distribute the chances unequally. This fundamental tenet of all research are - as Evelyn Keller puts it: "nowhere more dramatically in evidence than in the successes of nuclear physics and molecular biology, that is, in the production of technologies of life and death" (Keller 1992, p 9).

The softer disciplines, social sciences and the humanities usually shrink at the thought of being implicated in such instrumental activities as indicated above. We agree with Samuel Weber that "The future of the humanities may well depend on the capacity of … society to admit and accept the fictionality of what it assumes to be real, as well as the reality of its fictions" (as cited in the introduction to Diprose & Ferrell, 1991). The social sciences are presented with a similar understanding of their productive/ instrumental role in Dorothy Smith's writings. We return to this point.

Impacts of our knowledge constructions are independent of whether our results are judged to be true or false, valid or not. Following this realisation we can trace a shift in focus from what in the anglo-american philosophy of science is called "context of justification" to an interest in developing more complex and integrated understandings of knowledge processes in the late modern research complex. In order to handle the political and ethical implications and responsibilities involved in knowledge production, we need understandings and concepts of knowledge that help us become aware of these dimensions, suffice it no longer just to claim our scientific products as "true" or "valid". Jane Flax formulates the necessary shift in the following way: "I would like to move the terms of the discussion away from the relations between knowledge and truth to those between knowledge, desire, fantasy, and power of various kinds" (Flax 1992, p 457). We read this move or shift as expanding on what we presented as our "headline challenge" at the beginning of this chapter. We like to underwrite that this is not a call for any old or new liberal individualism. But we think Wendy Hollway has made a point by stating: "Science as we know it could only become dominant because it was preferred" (Hollway 1989, p 122). Struggles to become aware of and change such preferences will be a central part of research transformatory projects.

The Science Question in Feminism - once more

It is not difficult to gathered support for such a move in international feminist discussions. Sandra Harding's The Science Question in Feminism (TSQIF) was an important text convincing us of the need to put our knowledge constructions and ourselves at risk, it convinced us that feminism first and foremost was a movement for winding up privileges, privileges of knowledge as well as other privileges. What distinguishes feminist criticisms of science from other critiques and struggles against racism, colonialism, capitalism and homophobia, from the counter culture movement of the 60s as well as the contemporary ecology movement, is according to Harding that

> *the feminist criticisms appear to touch especially raw nerves……. Perhaps most disturbingly, they challenge our sense of personal identity at its most prerational level, at the core. They challenge the desirability of the gendered aspects of our personalities and the expression of gender in social practices, which for most men and women have provided deeply satisfying parts of self-identity.* (Harding, 1986, p. 16/17)

> *This characterisation of feminist criticisms was reformulated as a challenge to feminists in a text that followed and expanded on the last chapter of TSQIF: "I want to talk here about some challenges for theorizing itself at this moment in history, and, in particular for feminist theorizings. Each has to do with how to use our theories actively to transform ourselves and our social relations, while we and our theories - the agents and visions of reconstruction - are themselves under transformation.* (Harding, 1987a, p 285)

We find Harding's texts brilliantly arguing for and pointing to a reflexive turn where feminists' labour of change includes ourselves. But how do we deal with such a challenge in everyday research? From what was received in the first round of reading TSQIF, we suspect that we lacked both the readiness and the means to meet her challenge, as well as giving in to pressures towards legitimacy by reading Harding's text as a guide to different ways to ground feminist research[33].

Harding understands the epistemologies she identifies as strategies for legitimating research. They are produced in and for a "context of justification". She also explicitly characterises them as transitional: "Gender-sensitive revisions of modernist epistemologies have provided the main justificatory resources for feminism ….. Thus I propose that we think of feminist epistemologies as still transitional meditations upon the substance of feminist claims and practices" (Harding, 1986, p 141). This point is also underwritten in Feminism & Methodology (Harding, 1987b, p 186). But there is also something about these epistemologies that can be of use for feminism's transformatory projects, Harding contends. In TSQIF she describes the conflicts and the contradictions in and between them (Harding, 1986, p 24), because this makes it possible for us to "formulate new questions about science" (p 29). She points to such contradictions and conflicts as resources for our future oriented, transformatory struggles.

We want to follow Harding and maintain that "reflexivity" is a critical ingredient in a transformative competence. A claim for reflexivity also links up very nicely with Flax's move. Reflexivity is on the agenda in science studies, as well as in Haraway's and Braidotti's struggle for respectively "situated knowledges" and "critical feminist theory/epistemology". Harding's own Whose Science? Whose Knowledge? (Harding 1991) can be read as one extended argument for the necessity of reflexivity. This centrality of reflexivity is due to the researcher's obvious role as mediator between "society and science". In spite of this entire struggle, we argue that the claim for reflexivity has as yet to be adequately met.

The reflexive turn that we extract from Harding's recommended strategy, requests an open process. The pressures toward legitimacy and grounding, seem to demand closure. TSQIF can be read as a warning not to mix up the work for legitimacy with our future oriented, transformatory work. More often than not, the claim for reflexivity has proved its impotence by being directed at "others". We have also noted that the claim for reflexivity has deteriorated to a project of grounding one's own knowledge claims. Considering the strong influence of Marxist theory in critical traditions in Nordic countries, this is a very easy slide. To position oneself in relation to marginalised or victimised groups, has been interpreted as legitimating one's knowledge claims.

[33] See, for example, Taksdal, Widerberg (1992), Kunnskapsproduksjon og kjønn, skriftserie 3/91, Centre for Women's Studies, University of Trondheim, as well as the program for basic feminist research in the humanities, NAVF, Oslo (1989).

Rosemary Hennessy is among those, who contend that standpoint epistemology can be developed beyond projects for grounding knowledge claims. She concludes her discussion of the possibilities in standpoint epistemology by stating: "Once the feminist standpoint is formulated as this sort of dis-identifying collective subject of critique, the emphasis in its claims for authority can shift from the grounds for knowledges - women's lives or experience - to consideration of the effects of knowledge as always invested ways of making sense of the world" (Hennessy, 1993). We find an interesting parallel to Hennessy's discussion in a text from the "other side", the natural sciences, in Evelyn Keller's Secrets of Life Secrets of Death. Keller pursues here her "mediation-project" from 1985 by adding a focusing of how science works as well as what science works at. It is not enough to contend that it works.

Aino Saarinen describes a move from "different views on reality" to "different views on science" in Feminist Research - an Intellectual Adventure? (Saarinen, 1992). We like to connect this move to the one Harding projects as she takes the discussion from "the woman question in science" to "the science question in feminism". If we accept that there are different legitimate understandings of science, it seems to us that we must be prepared to include more of the construction of the map in the map, as any self-evident common grounding for knowledge production has broken down. The claim for reflexivity is given added weight by such a multicultural challenge. This is a challenge that cannot be held at arm's length, or (dis)placed with others. Not only everybody else's (or particular others') science, objectivity and rationality is up for deconstruction, investigation and eventual reconstruction.

Reflexivity and authority

During graduate studies and postdoc work we learn to pass as researchers with authority in the academic world. Internalising the rules and norms that constitute the chosen discipline, also implies the assimilation of a complex of tacit or informal knowledges. As Gerholm and Gerholm put it: "… the things you learn by acquiring a discipline are by no means only knowledge of a certain kind and technical skill but also a "cultural framework" that may come to define a big part of ones life" (Gerholm, Gerholm 1992 p 14).

One important aspect of informal knowledge is the notion of authority or lack of authority in a text. The ability to recognise such authority is hard to make explicit and thus difficult to achieve. "Very few scientists can answer questions about why certain texts give an impression of "competence" while other texts don't." (Gerholm, Gerholm 1992 p 25). Gerholm and Gerholm describe this ability as a feeling for how authority is created in a text or a lecture, for what counts as an argument, for the common attitude towards the surrounding world and for the personal style accepted by colleagues.

In order to exemplify how we learn to achieve authority, we will use an example from the discipline of particle physics in US given by Traweek's text. (Traweek, 1988)

Renewal of physics takes place by training novices. Particularly important in this process is "the informal annotations of everyday experience called common sense" (p 74). What constitutes common sense seems to be strongly regulated, as this research culture select only a very narrow,

overwhelmingly male group of researchers. Concerning authority inside the discipline one important aspect is whose interpretation of physics is not to be challenged. This is mediated through the textbooks and constitutes a kind of context markers in the discipline. Traweek contends that alternative interpretations at the same level of analysis do not exist. The student is taught analogical thinking, not induction or deduction. The sublime messages are "that science is the product of individual great men, that this product is independent of all social or political contexts, that all knowledge is dependent upon or derivative from physics, and that the boundaries of particle physics are rigidly defined" (Traweek, 1988, p 78). Another explicit message to the students is the stated fact that there are only a dozen major research laboratories in the world serving as the places with real authority and which determine the agenda in particle physics.

To be recognised as a serious physicist committed to the work, you have to develop a certain style. The Americans have focused on competition. This is a delicate act of balance in relation to the elders, the supervisors, who are giving tacit and explicit instructions. These intricate factors of achieving authority as a researcher stands in bright contrast to the physicist's own conception of belonging to an elite, whose membership is based on scientific merits exclusively.

Traweek gives voice to an experimentalist with a certain distance to the experiences of being a successful postdoc. This experimentalist maintains that to be successful you have to be a relatively immature person. "… a mature person would have too much difficulty accepting the training without question and limiting doubts to a prescribed sphere. He felt that this precondition kept most women and minorities from doing well; their social experience had taught them to doubt authority only too thoroughly" (p 92). Our transformatory ambitions press us beyond this "doubting" stand and to questions about how we can become aware of and convert our implicatedness in the problems and crisis into resources for transformatory projects.

Legitimacy in and through texts

Texts are written, read and deeply constructive. As Dorothy Smith puts it "People scattered and unknown to one another are coordinated in an orientation to the same texts" (Smith 1990, p 168). Public textual discourse creates new forms of relations, social as well as political and economic. Discourse is here understood as an ongoing intertextual process (or an ongoing "conversation") mediated by texts among speakers and listeners separated from one another in time and space. (Smith 1990, p 161)

In Texts, Facts and Femininity Dorothy Smith discusses the concept of discourse, in which we find the textual character of the ruling apparatus. If we recognise our established science communities as "the ruling apparatus" it deepens our understanding to look at "facts", produced in this apparatus as something arising in processes mediated by texts. Knowledge as facts, as have been discussed with the examples in physics given by Traweek[34], is sanctioned by the ruling apparatus after fulfilling both explicit and implicit conditions. As Smith puts it: "The notion of 'fact' …. indicates a recurrent

[34] In a context of natural science like particle physics communication of knowledge in various kinds of "texts" is illustrative. (Traweek 1988, p 117 ff). The different forms of expressions (texts) has specific functions. Oral communication of results is fundamental in order to maintain the whole complex of the discipline and to operate in the physics community. Written texts as preprints are used to verify results. Finally knowledge in texts published in scientific journals with referee system gives property rights of the formulation of the results to the author(s).

orderliness of movement from locally ordered observations to the textually mediated discourse … “ (Smith 1990, p 215). She advances the notion by stating that “facts” arise in processes mediated by textual forms.

The mediated texts in the science communities constitute the discourse, in which the scientific discussion and development take place. Dorothy Smith emphasises the discourse to be an active social process, which leads us to the assumption that processes of producing facts are far more intricate than we have learnt in our academic education (especially if we are natural scientists or engineers). A more complex understanding of these processes is needed for dealing with transformation and legitimacy inside as well as outside the scientific institutions.

Helga Novotny stresses that knowledge are to be accepted or taken for granted not because of claims on higher scientific authority, but more because of negotiations. This point is grounded in a desire of knowledge that is open for and sensitive to many contact surfaces, where contemporary knowledge, in very heterogeneous contexts, is born. She also finds that these contact surfaces have one thing in common. They are messy. Instead of being distinctively separated, they are overlapping. Instead of clear answers we get contradictions. Everywhere we have to make choices just to face a demand for a new choice around the corner. The world seems transformed to a labyrinth. (Nowotny, 1994) This is certainly evident in fast growing research areas like the converging biotechnology, information and communication technology and nanotechnology although the labyrinth conception is repressed at the expense of a more controllable and straight one.

Chapter 3

In interdisciplinary research the question of relevance is often placed in realities outside the walls of the university, within which I frequently find the cherished so called curiosity-driven research, which is supposed to find its relevant problem solving application in the future. Problem identification of known needs characterized FRN (the Swedish Council for Planning and Co-ordination of Research[35]). This implied FRN to be a unique research council developing an advancing expertise in interdisciplinary research and support for its practice. I learned a lot about not only interdisciplinarity but also transdisciplinarity (a la Gibbons and Nowotny) during the years I was involved in FRN as a board member as well as in a research political assignment commissioned by the Swedish government, an assignment FRN coordinated. My reference frame, indicated in the introduction and upon which I anchor my thinking and research, goes in the direction of interdisciplinary and transdisciplinary approaches, which this chapter deals with.

From Interdisciplinarity to Transdisciplinarity

Interdisciplinary challenges

> *Until we can articulate an adequate response to the question of how "nature" interacts with "culture" in the production of scientific knowledge, until we find an adequate way of integrating the impact of multiple social and political forces, psychological predispositions, experimental constraints, and cognitive demands on the growth of science, working scientists will continue to find their more traditional mind-sets not only more comfortable, but far more adequate. And they will continue to view a mind-set that sometimes seems to grant force to beliefs and interests but not to "nature" as fundamentally incompatible, unintegrable, and laughable.* (Evelyn Fox Keller 1992, p 36)

> *Production of new knowledge is largely a self-organizing process, following non-linear dynamics – difficult to foresee and synchronize knowledge coming from different disciplines.* (Helga Nowotny 2005a)

Interdisciplinary research is commonly recognized as problem oriented[36]. A project developed on the basis of an identification of the research problem - either from outside or from within the complex

[35] Forskningsrådsnämnden

[36] For a thorough introduction see Uno Svedin et al. TVÄRVETENSKAP – HUR, AV VEM OCH VARFÖR (Interdisciplinarity – how, by whom and why), Rapport från Expertgruppen för tvärvetenskap under Samverkansgruppen för Tvärvetenskap, Genusforskning och Jämställdhet (Report from the Expert Group for Interdisciplinarity under The Committee for Cooperation between Swedish Research Councils), Stockholm den 2 September 1999.

of science - is carried out by researchers from a number of different academic disciplines that may or may not be closely related. The "span" of the interdisciplinarity can vary quite considerably. There is what we can call short-span co-operation, between fields being fairly closely related, such as the disciplines of natural science, engineering and medicine, and at the other end of the scale there are wide-span projects ranging over distantly related or unrelated fields, for example co-operation between the disciplines of natural science and the humanities. In the latter case, we are dealing with a group of people who come together in some way or another, all carrying their different theoretical and methodological "baggage", in terms of training and ontoepistemological positions. The group is formed with an expressed goal of carrying out research into a problem that requires perspectives, theories and methods from more than one discipline in order to be solved or for knowledge and understanding of it to be developed. However, interdisciplinary research can also be done by one scientist with a background in several different disciplines, or by a scholar who approaches the problem from one discipline initially and works her way into other disciplines. In this latter case, the likelihood of interdisciplinary research creating new and intertwined theoretical (and even methodological) practices is perhaps even greater than in the former.

One, however trivial, measure of the degree of interdisciplinarity of a project is to analyze the degree, to which the results of the project are presented in articles written jointly by the participating researchers. If this is not the case, then it might be more appropriate to refer to the project as *multidisciplinary* rather than *interdisciplinary*. Indeed, this seems to be the case more frequently than not, even though we blithely use the label of interdisciplinary research. I am quite aware of the hard work needed, not only to realize a joint interdisciplinary project based on creative and well-functioning collaboration between researchers from widely differing scientific backgrounds, but also to allow the interdisciplinary work to have an impact on the culture of the individual disciplines in form of theory development etc.

When discussing the processes of knowledge production in interdisciplinary research, members of the academy often place great emphasis on the importance of scientific education in one established and distinct discipline. A well-defined, codified and legitimate base of theory and method is needed in order to successfully be involved in interdisciplinary collaboration with partners from other disciplinary traditions. This opinion is opposed to other members trying to accomplish a system of education and research based on overarching "themes". The discipline of technology is by its very constitution interdisciplinary - it is made up of "projects" based on knowledge from long and accepted academic traditions, although it is of course interdisciplinarity of the "short span" kind, in this case between mathematics, physics, chemistry, computer science, etc.

If the need for interdisciplinary research is rooted in recognition that single-discipline-based research is insufficient to solve the problem at hand or produce the required knowledge, then generating interaction between the participating disciplines suddenly takes on certain urgency. The "risk" associated with this kind of interaction is that it may well bring about changes in the theoretical and methodological norms of the single discipline. We all know what kind of fear, prejudice and protective behaviour such border-crossing processes may entail. If the majority of academics still harbour such fears and behavioural patterns, then a minimum requirement must be the introduction of a focus on the development of epistemological competence in graduate and

post-graduate education for the system (discipline) that is to foster interdisciplinary education and knowledge production. In the humanities and social sciences it might not be necessary to focus on this kind of competence, since it is already part of the curriculum. However, I have experience enough in the natural sciences and engineering to maintain that we are faced with widespread epistemological illiteracy in these fields. By taking myself as an example, I want to emphasize that developing interdisciplinary practice is hard work - not only with regard to the interdisciplinary project itself, but also with regard to the scientists' own intellectual and scientific prerequisites for this.

My and my colleagues experience of interdisciplinary work emphasise the disciplinary boundary crossing functions as a catalyst for getting in touch with trunks of informal and tacit knowledge. This knowledge is either too obvious to be noticed or so intimately connected to our sense of self, experience of self or disciplining and therefore not available for reflection and transformation in our 'normal' everyday research activities. Trying interdisciplinary transformations thus become both means and ends, which gives a character of process to my work.

Helga Nowotny (2005a) gives five arguments for the interdisciplinary research she finds easy to argue for but still difficult to realize. The headings and short comments on the arguments cited below are rather strictly situated in the context of academy, which should be kept in mind when comparing with her way of arguing for transdisciplinarity that follows further below;

- The world has problems the university has departments – but how to translate 'real world' problems into scientifically feasible as well as scientifically attractive problems?
- The whole is more than the sum of its parts – but how to arrive at a timely synthesis of different specialized bodies of knowledge?
- Knowledge, skills, methods and instrumentation often cut across disciplinary boundaries – but how to know which knowledge, skills, methods and instrumentation are useful and can be transferred from one field to another?
- Serendipity and the new discoveries often occur at the borders of established research fields and / or disciplines – yes, but if we only knew in advance where it will happen
- Industrial research exemplifies that it is possible to work in an interdisciplinary way with good results – but industry is mainly engaged in development (applying already available knowledge) and universities do not work like industry.

An interesting position is given in a noteworthy report from the prestigious Academy of Finland on a study from 2004 of the approaches towards and practice of promoting interdisciplinary research at the Academy (Bruun et al. 2005). The report is interesting because the authors thoroughly discuss Gibbon's and Nowotny's way of identifying knowledge production in mode 1 and mode 2 in a whole chapter named the rhizome model of scientific knowledge production. This pushes the interdisciplinary and transdisciplinary question some steps further. One general conclusion (p 59) not specific for the Academy though is that "interdisciplinarity is more or less everywhere, in and between all disciplines, even if the distribution is uneven. A sign of this change is the huge literature on interdisciplinarity, research collaboration, analogy, networks, innovation and so on, that has been

produced in the past decade. The implications of the transition towards a more rhizomatic science are not obvious yet, but they are certainly a worthy object of future research." A clear recognition of the importance of interdisciplinarity is there but at the same time a guarded adjustment to the strong disciplinary norm of the Academy by for instance stating that "one should be careful not to emphasize the importance of integration too much." (p. 68).

The interdisciplinary question as an epistemological project

My reflections about interdisciplinarity are firmly rooted in my position as a feminist technoscientist. Among feminist researchers there seems to be a general consensus that feminist research is interdisciplinary. Why is this? On what grounds is this statement based? One obvious reason for this claim of interdisciplinarity is the way in which feminist research entered the academy in Sweden. The development of feminist research within the universities started at the end of the 1970's. Centres for women's studies and female researchers, as it was called in those days, were established at the main universities[37]. These centres brought together feminist researchers from different disciplines and in that sense created an interdisciplinary environment having various and important impacts. The Swedish government recognized[38] the centres as independent but co-operating authorities with an interdisciplinary focus of importance to feminist researchers and female scientists alike. Many of the activities conducted at these centres concern education. The courses they provide[39] were and still are based on predominantly interdisciplinary approaches. An example from Denmark shows that the Danish centres for women's studies organized a joint interdisciplinary PhD programme called "The meaning of gender in an interdisciplinary perspective". The courses offered in this programme of study considered epistemology, theory and methodology as well as specific subjects. The PhD programme was approved by the Research Council of Humanities and the Danish Research Academy as part of the established research education in the country. It was followed by a Nordic Research School in Interdisciplinary Gender Studies starting in 2004. Another example is the consortium and research school on interdisciplinary gender Studies called InterGender[40] coordinated by Tema Genus at Linköping University, Sweden. The background to the consortium is the Swedish-International Research School in Interdisciplinary Gender Studies, InterGender, funded by the Swedish Research Council with 12,5 million SEK, 2008-2014. This research school organized 27 international PhD courses in intersectional gender studies as well as three international conferences with a main focus on PhD students' participation and training.

However, I am not convinced the feminist researchers themselves are doing interdisciplinary research. Most of the researchers I have met in these autonomous centres and departments for gender studies are working on more discipline-based projects. In a Nordic context, Solveig Bergman (1995, pp. 120, 121) states that

[37] See introduction

[38] As an example in the Research Bill to Parliament "Research and Society" (Forskning och samhälle), Prop. 1996/97:5, p. 55.

[39] more information can be gained at www.genus.gu.se

[40] InterGender offers a large scale research training program meeting the needs of PhD students in different phases of their training. The main modules are offered every year on a rotating basis, thus coordinating the respective specialities of the different partner institutions, as well as the different needs of first-, mid- and last-phase PhD students.

> *most of the gender researchers have their activities located in the traditional academic fields and disciplines. At the same time a distinct infrastructure of interdisciplinarity has evolved for gender research. This infrastructure consists of gender research units (centres for women's studies), national co-ordination, scientific journals, national scientific organizations, seminars and conferences.*

A common feature of all feminist researchers seems to be an interest in and practice of feminist theories development together with methodological considerations[41]. And this is more or less a reciprocal interdisciplinary "project"[42].

What we are seeing here then is an interdisciplinary "project" situated in a cross-section of a very rare kind. It is an epistemological project and as such it spans over the borders between all the disciplines. Feminist research works in quite an informal manner and can be applied wherever you need it. You can pick and choose according to your own preferences and context, and you contribute to its ongoing development by participating in all kind of academic and non academic activities.

Above I stated interdisciplinary research to be commonly recognized as problem-oriented. The feminist research I have encountered at faculties of technology is generally motivated by means of identification of a number of serious problem areas, especially when we consider issues such as information technology and biotechnology and its multidimensional potential and capacity from global and environmental perspectives. In technology, the complex of problems is concerned more with production of knowledge about the realities of everyday life, than knowledge production as a base for creating material and immaterial goods. In order to develop complex understandings and to be an intervening partner in the production of knowledge in question, you have to be able to *become answerable for what you learn how to see* [43]. This ambition is correlated to the view of science as cultural practices and in this respect it is necessary to raise accountability both within and about it. Elisabeth Gulbrandsen has placed the "accountability challenge" in our research-dependent society explicitly on the agenda in Nordic feminist research. She writes (Gulbrandsen 1995)

> *In the aftermath of the 1992 UN Conference on Environment and Development in Rio de Janeiro, Wolfgang Sachs presented a fresh image of our predicament as a research dependent culture. We are no longer driving like mad towards the edge, Sachs contends; we are driving at full speed along the edge, equipped with state-of-the-art surveillance gear, as well as expertise in risk calculation and environmental management. According to Sachs there is no reason to receive this "news" with relief. He expresses grave doubts whether such later generations of environmental technologies are adequate responses to hazards created by earlier generations of technoscience products.*

To those of us who have invested our efforts in struggles to further research informed by environmental and developmental concerns, Sachs' image is highly disturbing, suggesting that all our hard

[41] Which can of course never be separated from theory.

[42] This is something quite far removed from my theoretical background, which is theory of thermal degradation in pyrolysis gas chromatography.

[43] and work yourself away from the nurtured god-trick of seeing everything from nowhere. Haraway, 1991, pp. 189, 190.

work is rapidly being converted into the new growth-industry of environmental management[44] and losing its transformative power. The impotence of our critiques of science seems glaringly exposed - yet again?*

In the same text she refers to Donna Haraway, saying (1991, p. 201) "Perhaps our hopes for accountability, for politics, for ecofeminism, turn on revisioning the world as a coding trickster with whom we must learn to converse".

The impact of the indicated problem identifications having motivated feminist research is not the creation of interdisciplinary alliances and projects to solve the concrete problem as such, but the focusing on the fundaments of the phenomena / factors *creating* the problem in the complex of knowledge production. This is why the specific cross-section of interdisciplinarity is of an epistemological nature gathering a number of feminist researchers from different traditional disciplines to undertake the self-reflection necessary within the research complex.

Platforms for generating interdisciplinary practice

How then do interdisciplinary practices within feminist research evolve? By what means can we proceed from the imaginary space in which our mutual, interdisciplinary, epistemological "project" takes place, to create a space within everyday life for concrete interdisciplinary work?

Case 1 One experiment has taken place at Luleå University of Technology. There was a research department at the university called Gender and Technology, which was established as a department at the beginning of 1994[45]. During a relatively short period of time, this theme attracted a group of researchers and PhD students with very different disciplinary backgrounds, ranging from human work science, computer science, chemistry, the history of ideas, medicine to environmental planning and design - in other words a very broad-span research group.

The research projects at the department in the late 90a were divided into four broad areas, namely

- Information technology
- Processes of research, knowledge and learning within technoscience
- Work and health
- Technology and the Third World

It was crucial to find forms that paved the way for a joint development of theory and method, and work was initiated in a joint research program with the title "(Techno)scientific challenges in feminist research" and encompassing the themes:

- Technoscience / the concept of technology
- Feminist research perspectives

[44] "Global Ecology and the Shadow of 'Development' " in Wolfgang Sachs (1993).

[45] However, there had been feminist research activities within the technical faculty of Luleå University of Technology since 1982.

- The research complex

These topics constituted important cornerstones for the various individual research projects within the program. The joint program consisted of work seminars with invited guest researchers and text seminars, and less formal forms of work in terms of the constant discussions about experiences gained from the different assignments performed by the members and which could be related to one of the three sub-themes.

The results of the experiment included:

- recognition of a degree of epistemological competence in the group of researchers far more substantial than normally identified in a department of engineering
- a general capacity for reflection on science in a way that contributed to the construction of bases for interdisciplinary understanding among students both within the department and elsewhere
- motivation among members of the research group to draw attention to their contributions to the development of methodologies and theory and for these to be recognized as a scientific competence in academic theses
- members of the research group (both individuals and groups in a variety of different constellations) was invited to run external interdisciplinary projects

Case 2 Another interdisciplinary platform requiring a deep interest in and concern about "what we learn how to see" in our positions as researchers at technical faculties was the Graduate School for Women at the Technical Faculty at Luleå University of Technology (Trojer 1999).

The Graduate School for Women was the first graduate school for women in Sweden, as well as the first one specifically located within a technical faculty. It was launched 1 September 1995 and was set to run for three years. The explicit aim behind the Graduate School was to increase the number of female research supervisors, teachers and managers within the technoscience sector, and also to support the recruitment of women to higher technical education and research. The project was expected to contribute to the ongoing process at the University of developing a new model for a form of research education, well functioning and able to take into account the preconditions and needs of each individual research student.

The 15 participants in the Graduate School scheme were selected from among female graduate civil engineers and female research students at the faculty of technology – research students who had not been engaged in research for longer than one year. The recruitment included the supervisors of the female research students (all male). The research students represent nine different departments at Luleå University of Technology namely; Computer Science and Electronic Engineering, Civil and Mining Engineering, Mechanical Engineering, Human Work Science, Mathematics, Environmental Planning and Design, Materials and Manufacturing Engineering, Chemical and Metallurgical Engineering, Business Administration and Social Sciences.

The Graduate School program was included in the study plan for each individual research student and contained mainly faculty courses, higher seminars and different development projects.

Successful research supervisors must have a great interest in research, education and leadership, and this was reflected in the programme for the Graduate School, which focused in particular on communication, pedagogics, processes of research, theory of science, project planning and financing, organization, personal development and leadership in research organizations.

Although the Graduate School for Women was not an explicitly interdisciplinary project, the curriculum of the Graduate School included competence building with parts vital also for interdisciplinary practice. The latter can be characterized by epistemological awareness and reflection as well as communication competence at several levels. The participants in the Graduate School project created a strong network among themselves. All the different meeting situations evolved in this network contributed to increase the participants' curiosity in each other's field of research, ways of doing research and identification of scientific needs. The co-workers in the Graduate School were also able to satisfy each other's needs to a certain extent, as this network promoted questions, discussions and openness. Interdisciplinary collaboration occurred spontaneously - although it arose most easily between people with closely related disciplinary starting points.

Perhaps the most adventurous co-operative constellation was that between the students of the Graduate School and students from Luleå Theatre Acadmey, which belongs to the same university. This collaboration occurred in connection with the course in Leadership in Research Organizations. One of the central issues in this course concerned the prerequisites of and conditions necessary for creative work and knowledge production in leadership perspectives. The angle of knowledge in the body as well as in the intellect was also addressed from this interdisciplinary perspective. This coming together between culture and technology yielded a wealth of undreamed-of possibilities.

Attempted transformations

Above I briefly mentioned the "risk" of changes in disciplinary norms entailed by interdisciplinary research. What are the views of the researcher herself and her colleagues in the receiving discipline about interference caused by and integration of the results of interdisciplinary research into the disciplinary traditions of the mother subject? Here we touch upon the fundamental issue of the possibilities for and obstacles impeding the movement of theoretical and methodological traditions within a single discipline. Creating new knowledge means changing discourses - an old discourse is to a certain degree replaced by or transformed into an altered one. We can imagine many varieties of inertia and unwillingness to create new discourses. However, knowledge production cannot be recognized as research if new discourses are allowed not to evolve. The new discourses are always negotiated in the research complex[46]. The discourses of interdisciplinarity - the transformed theories and methods that emerge from the impact of real interdisciplinary work - are issues controversial at many levels. They are not the least the subject of debate on the level of research policy, nationally as well as internationally.

[46] Helga Nowotny (1994) emphasises that knowledge is accepted or approved not on the grounds of claims of higher scientific authority but on grounds of negotiations.

Transdisciplinarity

> *Nobody has anywhere succeeded for very long in containing knowledge. Knowledge seeps through institutions and structures like water through the pores of a membrane. Knowledge seeps in both directions, from science to society as well as from society to science. It seeps through institutions and from academia to and from the outside world. Transdisciplinarity is therefore about transgressing boundaries. Institutions still exist and have a function. Disciplines still exist and new ones arise continuously from interdisciplinary work. Therefore: beware!* (Helga Nowotny 2006)

Every now and again I have come across the concept "transdisciplinary" in a scientific text. On such occasions, I tend to get excited and anxious to know what the author(s) are intending by using this term. To me, it calls to mind immediately an image of epistemological thinking that is directed towards the problems and challenges we face in our complex society and in future-oriented competence building for transformative research and knowledge production. In Gibbons et al. (1994) transdisciplinary research is characterized by the final solution normally being beyond that of any one of the contributing disciplines. The authors identify four features of transdisciplinarity[47]:

- It develops a distinct but evolving framework to guide problem-solving efforts. This is generated and sustained in the context of application.
- It develops its own distinct theoretical structures, research methods and modes of practice, though they may not be located on the prevailing disciplinary map.
- The diffusion of the results is initially accomplished in the process of their production. Subsequent diffusion occurs primarily as the original practitioners move to new problem contexts rather than through reporting results in professional journals or at conferences.
- It is very dynamic. A particular solution can become the cognitive site from which further advances can be made, but where this knowledge will be used next and how it will be developed are as difficult to predict as the applications that might arise from single-discipline-based research.

The relevance of using a concept like transdisciplinarity proceeds, when we recognize knowledge production to take place increasingly in open and distributed systems, see Part IV. A characteristic of the concept is transdisciplinarity to create and maintain its own problem solving framework, methodologically as well as theoretically, in the context of application. Nowotny et al (2001, s. 223) state "…transdisciplinarity is achieved by focusing on research problems as they emerge in contexts of application and where the heterogeneity of knowledge producers introduces additional criteria of assessment apart from scientific quality". Transdisciplinarity is thus not only an issue of converging and go beyond established disciplines. It is an advanced cooperation between the academy and a heterogeneous group of knowledge producers outside. The constellation of participating actors is specific for each case of problem solving.

[47] Gibbons et al, 1994, p 5.

Platforms for generating transdisciplinary practice

Case 1 One experiment of raising transformative competence in an interdisciplinary or more likely transdisciplinary research project is given by a project concerning water and sanitation technology also including strong environmental and feminist research connections[48].

The goal was production of knowledge, primarily of a specific situation in an urban area in South Africa. But situated knowledge[49] was also developed by certain involved authorities in Sweden. One of the cornerstones in the project was to explore the advantages of participatory methods[50] and their use in feminist engineering (Rydhagen 2002).

As one of the most crucial prerequisites for survival, water is of pivotal interest for this kind of study. The infrastructures for water supply and sanitation for the poorer sections of society are seldom adequate, and the emphasis on community involvement in the improvement of these conditions is increasingly being recognized as a central part of the solution to the problem. The unbalanced concentration on piped water and sewage systems is concurrently giving way to a variety of in-situ solutions with simple, low-cost technology. Methods for successful community involvement and low-cost, in-situ solutions for water and sanitation are still under development.

Much research has been undertaken concerning the relationship between water, sanitation facilities and health in developing countries. As this relation is very complex, it would be naive to expect to find a universal explanation to the problem of water-related diseases, and advice on effective disease prevention is far from unambiguous. Studies indicate that water *quantity* is at least as important as water quality in the determination of health standards in individual households. Thus, the time and effort spent on water collection and the responsibility for this activity are of great relevance, and domestic water and sanitation activities are of course highly gender marked.

The aim of this project was to move gender issues from their minor role within the evaluation process into the heart of technology development and research. During the research process it became increasingly clear there is a lack of cross-fertilization between feminist theory and what is called “gender awareness” in development work and assessments. Feminist theories can often be rather abstract, discussing hierarchical relations in society in general terms. Development workers working on concrete projects, on the other hand, talk about gender roles in the specific situation without drawing any connection to larger sociopolitical and cultural structures. Although gender is most frequently mentioned in connection with water and sanitation projects, the issue of how exactly gender awareness is supposed to influence the projects as such is seldom discussed in depth. Feminist research is rarely not brought in at any stage of technology development as a source of knowledge and competence.

The research goal of the project was to explore how gender / feminist theory and gender awareness can inform sanitary engineering in a way that will benefit as large a group of society as possible. By asking the engineering question in feminism, this project tried to move “gender” from the evaluation process into the very place where technology is actually developed. This is seen as a very urgent

[48] The presentation of the project is based on a research project accomplished by Birgitta Rydhagen.

[49] For a further discussion of the views on and interpretations of situated knowledge, see Haraway, 1991, chapter 9.

[50] The participatory research method used is called PRA (Participatory Rural Appraisal) and is described in Chambers,1997.

step, as it is becoming ever more obvious that the diffusion of technologies can be considered successful while at the same time it can have very detrimental consequences for people and the environment. The location of feminist research in a technical context is rather rare, and this project was an important element in the attempt to foster the inter- and transdisciplinary feminist and technology research praxis.

With this kind of study other agents enter the processes of research - both in form of people directly involved in the local technology development (PRA) and in the form of new theoretical perspectives (feminist theories and not just gender as variable). This in turn necessitates discussions and reassessment of traditional academic mindset. By traditional academic mindset I am not referring to a literal evaluation of our scholarly traditions, but rather of the kinds of appraisals performed in the everyday processes of the academy - in teaching, discussions with colleagues, in seminars and conferences or in per review situations (evaluation of articles, books, theses, appointments, applications for grants). The experiences gained both from the research as such and from the discussions constitute a basis on which the kind of research transforming competence necessary for creating the new discourses we need can then be developed.

Case 2 With the acknowledgment of academic praxis in a transdisciplinary context, that is daily work as researchers and teachers in a distributed system of knowledge processes, I want to make visible the research division of Technoscience studies at a Swedish, profile university focusing applied ICT, Blekinge Institute of Technology (BTH).

The main academic aim of Technoscience Studies is to develop complex understandings of information and communication technology (ICT) as reality-producing technology as well as of the dominant transformations that follow in its wake from the perspective of gender research within technoscience. This presupposes participation in the appurtenant processes of transformation and knowledge production. Seeing ICT as reality-producing technology rests on the idea that all of us, researchers in the field included, are enmeshed in development processes, where an innocent position does not exist. Information technology intervenes in and creates people's everyday lives. On the other hand, information technology is something developed and interpreted by people. The work of Technoscience Studies is aimed to create a theoretical basis as well as praxis for developmental processes in ICT-related disciplines as well as in the context of IT politics.

In international feminist research with strong links to the dominant technological fields of our age – information technology, biotechnology and material technology – there is a widespread understanding of the production of knowledge and technology as processes that take place in distributed systems. In other words, in this day and age knowledge is generated in the overlapping borderland of universities, companies and other regional, national and international actors. These processes are not least apparent in the region of BTH and affect the way in which BTH carries out R&D work. The term technoscience connotes this understanding of the production of knowledge and technology. The way in which technoscience is defined by internationally leading researchers such as Donna Haraway raises interesting questions about boundaries and the transgression of the boundaries between science, technology, politics and society, and between humans and non-humans, the processes of hybridisation between people and machines (cyborg theories), etc.

This transdisciplinary trying of Technoscience studies[51], which started in 1998 supported by the Swedish Government, became the base for undergraduate education in media technology. In the time window of 2016 its PhD program had awarded 16 doctor degrees.

Ontology of resistance

Although the results presented above can be – at least temporarily - satisfying for the development of an academic room for transdisciplinarity and even for feminist transdisciplinary environments, there are hard earned experiences of developing conditions that have to be fulfilled. One important condition is research political signals and support at a national level. This is further elaborated upon in Part III. Earmarked money, either from Government or other authorities, for these local trying transformations in a transformation rigid body like the academy means you don't have to put all your energy in fighting for resources at the boards of decision at your university. Instead you can focus on building alliances with the constructive forces within and outside the university that always exist somewhere and to some extent.

The condition I want to discuss is the willingness, strength, patience and understanding to encounter all the forms of resistance always occurring in transformation processes (Ahrenfelt 2001). One of my colleagues Peter Ekdahl has substantial experiences of this matter and has in his doctoral thesis (Ekdahl 2005) written about resistance in a faculty of technology, when establishing media technology as an inter- and transdisciplinary academic field for graduate and postgraduate education.

On the web page of ACT Lab (Advanced Communication Technology Lab, University of Texas), where Sandy Stone has been active, you could read[52]

> *You can't analyze New Media with old disciplinary tools (...) you can try, and you will evince data, but you won't really learn anything worthwhile. You need new tools, new methods, new disciplinary languages, and you won't find them waiting inside traditional disciplinary forms.*

Peter Ekdahl uses Bo Ahrenfelt to discuss transformation processes and the resistance following in the wake. Ahrenfelt emphasizes the need for – what he calls - a second order transformation and thus put established models for organisational change on the head. The organisation transformation he is referring to is highly relevant for the academy.

> *At transformations of a first order you don't change mindsets or behaviours in the organisation. What is actually happening is a recombination of old patterns keeping the organisation within the old tradition. The system is still intact and unchanged. However, at transformations of a second order mindsets are changing both as interpretation of*

[51] www2.bth.se/tks/teknovet.nsf/

[52] Citat från ACT Labs dåvarande webbsite http://www.actlab.utexas.edu (2000-02-20).

> *reality and in acting, which means the whole system has changed. We recognize reality in a new light and with a different understanding... Everything is altered and reality looks different.* Ahrenfelt (2001 p 23)

Ekdahl identifies the two quotes above considering transformations as a trying to break up prevalent mind and acting patterns and thus as an issue of changing the prerequisite of the system. The impact implies that the view of the self understanding, of humans and of life is put into question. This in turn affects the values within the system and interacting with other systems. Accordingly, transformations of a second order can't be predicted on beforehand. Predictions exist only in transformations of a first order, where the fundamental values are unchanged. The system of first order doesn't encounter the altered demands in the forms of needs and relations in our and future times. No wonder you have to face resistance in the academic organisation, and quite strong and unpleasant ones.

The last example for reflecting upon the ontology of resistance is a research political one. Swedish Council for Planning and Coordination of Research (FRN) was the research funding authority with a mission to support and foster interdisciplinary research and started its activities in 1977. FRN also managed research on problems of vital importance for society identified either by the Swedish Government or by themselves - problems which no other research financing authority paid attention to. FRN was a strong support to the Swedish universities with substantial ambitions to conduct interdisciplinary research as well as develop academic competences for the same. It also had a special assignment from the Government for supporting feminist research.

The monodiscipline oriented research councils never acknowledged the importance and relevance of FRN. In a turbulent research political period in the second half of the 1990s[53] strong (monodisciplinary) academic forces managed to have the Government deciding to discontinue the existence of FRN. We were in Sweden back to a research political situation of the 1950s. This was a real backlash for interdisciplinarity and beginning support for transdisciplinarity.

The transformation initiatives taken by FRN in order to encounter present day's demand of knowledge production met in the door a figure of resistance provoked in its most inner core.

[53] see chapter 7.

Chapter 4

In order to get closer to epistemological infrastructures used at a technical faculty, I take as an example the university, where I have been active as deputy dean for the faculty of technology as well as head of research at departmental level. How feminist technoscience can be a resource for research transforming processes deliberately trying to be answerable when society speaks back is shortly presented. The chapter contributes to the discussions about why an epistemological pluralism is needed at a technical faculty and why resources within feminist technoscience are relevant in this context.

Interventions in Epistemological Infrastructures[54]

The challenges technical universities encounter, when the cooperation with public and private partners outside the university becomes a predominant reality, calls for transformation processes and actions. This is certainly the case at a technical university with an explicit profile of applied ICT (information and communication technology) in a region with strong development ambitions. Epistemological openness among people active at the university is a prerequisite for functional cooperation. This chapter concerns distributed knowledge processes as daily experiences at one of the campuses of Blekinge Institute of Technology (BTH), more precisely at campus Karlshamn. What resources can be used for staying confident, future oriented and innovative as an ICT researcher and an academic teaching staff? Referring to a development experience with so far good results, when it comes to student recruitment, research and campus building, resources for the epistemological infrastructures needed have been found within feminist research developed within a technical faculty - that is, within feminist technoscience[55].

Rationale

At technical faculties we have to encounter complex realities in our research and pertinent address our cooperation partners in private and public sector. We also have to encounter young people and their preferences in learning processes of higher ICT related education. The challenges in this situation involve transformation in more advanced ways than what has been expected and realized in our academic organization with long standing norms of stability and epistemological traditions. One fundamental condition for the transformation needed is to open up for and foster epistemological pluralism.

[54] This chapter is a revised text presented at E-CAP, European Computing and Philosophy Conference, Mälardalens högskola 2005 06 04 and published (Trojer 2006) in Computing, Philosophy, and Cognitive Science, Cambridge Scholars Press.

[55] Please note that I use gender research within the technology / engineering disciplines and feminist technoscience synonymously.

Ina Wagner contributes with some significant understandings. She argues (Wagner 1994) that the central idea of combining established forms of scientific inquiry with a social pragmatic of developing goals, methods, theories and products can be realised by epistemological pluralism and partial translations between situated knowledges of different communities.

It can never be stressed enough that fostering of epistemological pluralism is a challenge at a technical faculty, however juvenile or old. When we have learned to spell the word epistemology, when we have acknowledged that we do research and teach by walking on a certain epistemological infrastructure, then it is high time to question this infrastructure whether it is relevant enough, is appropriate enough for our located needs. My local need is based on the following.

Situated at a technical university[56] with an explicit profile of applied ICT with ambitions to be in close cooperation between university, business sector and government (local, regional and / or national), the challenges are huge on the epistemological openness for staff active at the university. The present knowledge and technology production occurs in situations far from what is identified by a traditional, mode 1 (Gibbons et al. 1994) university. A too closed and none reflected epistemological basis is a blockage for the daily work whether research or training students at basic and advanced level. That is why I am concerned.

Situated within distributed knowledge production systems

There is a widespread understanding of the production of knowledge and technology as processes taking place in distributed systems within the international feminist research strongly linked to the dominant technical fields of our era - information technology, biotechnology and material technology. I and my colleagues at BTH, campus Karlshamn have been deeply involved in the complex development process of a distributed knowledge and technology producing system called NetPort [57] (Henningsson, Trojer, 2005). This is one of my most important learning sites of trying transformations in context of distributed knowledge processes.

Starting a new campus was a result of negotiations between the leadership of the university and the local government of the town Karlshamn, where the campus was to be located. At the same time the innovation node or innovation system NetPort was established. NetPort became later on an organization co-owned by the university, the local government and the business sector of the three focus areas chosen. The development of the campus and of Net Port started in the year 2000.

Developing a new campus for a university of technology in a Triple helix context needs at least 4 starting conditions, namely

1. undergraduate students
2. graduate students
3. epistemological acknowledgement of mode 2
4. tolerance towards resistance always appearing in development processes, especially internal.

[56] www.bth.se

[57] www.netport.se 2013 NetPort changed name to NetPort Science Park.

In the year 2000 the Vice Chancellor of BTH (later on Director General of VINNOVA (The Swedish Governmental Agency for Innovation Systems) and after that VC of Lund University) approved the research division of ICT and Gender Research[58] at BTH, to take the main responsibility of starting to develop the new campus. This task was supported by BTH with a centrally appointed project coordinator. The division had competence to start bachelor programs in media technology and was already running a PhD program with a number of doctoral students. The division staff was strongly motivated to work with practicing Triple helix collaboration.

For his approval the VC had become convinced of condition 1 and 2 above. Condition 3 characterized the practice of the VC and seemed to be self-evident for him. The ambitions of the division to fulfill condition 3 were probably implicitly recognized by the VC as explicit interest was demonstrated in cooperation with stakeholders outside the university, of which the local government of the campus city was the main partner.

Concerning condition 4 the division had great help of understanding different kinds of resistance manifestations by the experience of Bo Ahrenfelt (2001). Peter Ekdahl (2005) stresses resistance in development and transformation processes to be important and energy creating, even though resistance is momentarily experienced as destructive and energy sucking. Without resistance the possibilities to focus the own direction of the development work is obstructed. The sectors mobilizing the strongest resistance are often sectors were transformation work is mostly needed. In addition resistance helps to detail and clarify what kind of development and transformation terms you need and push for dialogue.

Mutual understandings

How can the situation of academic work in co-evolving processes with society be comprehended? If our aims are to produce knowledge encountering the need of society and being robust enough for sustainable purposes, then we have to be serious about how we understand our knowledge producing systems. Socially robust knowledge can only be produced in a mixed environment. The knowledge will then be exposed to more intensive testing in various contexts. It will not be pre-determined but open to re-negotiations (Nowotny et al. 2001). In addition the site of problem identification moves from the academy to the agora[59], where science meets society and contextualisation occurs. We are facing processes of non-linear character. This is far from our traditional perceptions of sequential processes in first knowledge making in basic research followed by applied research or dissemination to exploitation of the knowledge in products for a private or public market. Nowotny et al (2003, p. 191) articulated this issue clearly in

> *reliable knowledge, the traditional goal of scientific inquiry, is no longer (self?) sufficient in the more open knowledge environments that are now emerging; knowledge also needs to be 'socially robust', because its validity is no longer determined solely, or*

[58] The name of the division was later on changed to Division of Technoscience Studies.

[59] The agora is central places for public life. The concept agora embrace the political arena and the market place – and goes beyond both (Nowotny et al 2003, p. 192).

> *predominantly, by narrowly circumscribed scientific communities, but by much wider communities of engagement comprising knowledge producers, disseminators, traders and users.*

Strathern (2003, p.275) adds "Accountability is, of course, at the heart of the argument about socially-robust science, and its converse, scientifically robust accountability."

What is highlighted in our practice and reference literature is that science and society are subject to the same driving forces in

- pervasiveness of a new economic rationality
- transformation of time and space (not the least as effects of ICT)
- demands for self-organising capacity
- generation of uncertainties and risks[60].

These processes can be described as science and society becoming transgressive fostering society to talk back to science. Jasanoff (2003, p.225) addresses the driving force for society to speak back in stating that uncertainties and risks are "part of the modern human condition, woven into the very fabric of progress. The problem we urgently face is how to live democratically and at peace with the knowledge that our societies are inevitably 'at risk' ".

An important dimension of how science and society now speaks back and forth is the issue of input of resources and output of results. In the linear way of thinking science and society, we are used to focus on the input of resources whether it comes from the government, public or private funding agencies etc. Gulbrandsen (2004, p.109) argues that

> *One of the most pressing interrogations for science policymakers the last 20-30 years has centred on output; how to secure an output from research that complies with economic, social, cultural and ethical concerns. Or reformulated to suit our more immediate concern: How can universities assure that choices made by scientists and engineers on campus contribute to responsible innovation? This challenge has by no means been satisfactory answered.*

It gets increasingly evident that 'society speaks back' in forms of requiring to take part not only in the input phase but in the whole process (which more likely is non linear) up to the output of results. We have experienced in the NetPort context and on a municipality level how society represented by the local government explicitly manifest the *need* and *engagement* in being involved in the whole input - operation - output process[61].

The *engagement* comes from the mutual 'project' of fostering sustainable development of the local and regional society. The prerequisite for this 'project' is a triple helix-like process (Etzkowitz,

[60] Beck 1992.

[61] See chapter 11.

Leydesdorff 1997), which in our case is nurtured by a constant dialogue. In this dialogue, which is a kind of agora, mutual understandings starts to find its expressions and that in very concrete ways and a co-evolving process takes place. For us, who have been involved, we talk about an

> *establishment of the institution of a 'kitchen cabinet'. A generous, open, inviting, allowing arena had to be created for the construction of new questions and dreams …. We need a lot of 'kitchen cabinets' on campus to cater for the polycentric, interactive and multipartite processes of knowledge-making we may dream of. A vision that entails transformative processes, changing research cultures and "teaching smart people how to learn:*[62] (Gulbrandsen 2004, p.120).

By shortly presenting the situated knowledges I have experienced within a distributed knowledge production system, I hope to make sense, when it comes to my claim on epistemological pluralism for the transformation needed at technical faculties. Below I will elaborate on why and how feminist technoscience can be a resource for developing epistemological pluralism and thus innovation systems.

Feminist technoscience as a resource

The feminist research conducted within engineering sciences at technical faculties has come to focus on the fundamental knowledge issues and on their development of theories and methodologies. The pertinent questions of boundaries and the transgression of the boundaries between science, technology, politics and society insist on terminology like technoscience. One of the scientists in the forefront of developing complex understanding and practice of this terminology is Donna Haraway. When focusing boundaries we have to keep in mind that boundaries "do not sit still" (Barad 2003, p. 817) underscoring our complex realities.

A joint feature of feminist technoscience is its research transforming ambitions. In many ways this is an obvious basis. In an international perspective we are dealing with an increasingly radical project of transformation (Trojer 2000). It is not good enough for a researcher to discover and map a waiting reality "out there" – that is to stay in the context of discovery. Research must focus the context of application as well as context of implication (Nowotny et al. 2001, 2003). As stated in chapter 2 "Time is ripe for us as partakers in the modern research complexes, to develop a readiness to think and feel ourselves as part of the problem, and learn how to use this, our implicatedness, as resources for transformatory projects."

The notion of *situated knowledge* is emphasized in the technoscientific reflections. Haraway (1991, p.196) stresses that what we can reasonably bring about in our knowledge production can never be more than partial translations. Translations are always interpretative, critical and partial. These constitute the very condition to be heard, when we are claiming rational, relevant knowledge. Rational knowledge is founded within a process of ongoing critical interpretations among a number

[62] See Argyris (1991) and Nowotny et al (2001).

of interpreters. Rational knowledge includes power sensitive conversations. The world and its phenomenon, Haraway states, neither speaks itself or disappears in favour of one particular chosen interpreter or master decoder. The codes of the world do not find themselves silently waiting to be read.

We can ask ourselves why these kind of research activities are deeply involved in the development of a distributed knowledge production system like NetPort and is one of several driving forces in the development processes. The answer is to be found in some identified potentials and experiences of this research (Rydhagen, Trojer 2003, Björkman, Elovaara, Trojer 2005), namely to;

- expand the knowledge frames and practices for technology development in increasingly complex realities
- develop epistemological infrastructures relevant to a society heavily dependent on research and technology
- establish new arenas for developing understandings of relations between research, political sector and industry
- create driving forces for inter- and transdisciplinary constellations.

Building epistemological infrastructures

I recognize the necessity for co-evolving processes in core activities of our technical university. Relevance and situated knowledges compose keystones in our attempts to open up for the needed epistemological pluralism. We notice the transformation of the situated knowledge production in our context to move *from* contract negotiation / input focus *towards* co-evolution / the whole chain (input-operation-output) focus. The higher demand is obvious on the university and other stakeholders to argue for their relevance, in order to become an accepted partner in the present ICT knowledge development. From a university perspective this demand does not make academic knowledge production less motivating, less quality strong and a less desirable occupation, on the contrary.

What challenges are we facing in the near future as academics and feminist technoscientists at technical faculty and as co-workers in NetPort? The foremost challenge is the added value the core activities have to develop on a local, national and international level. The requirement is an intensified cooperation between the main triple helix actors – university, local government and private / public sector. We have to go further in the process of trilateral arrangements and sometimes even assuming the role of the other when needed and join in the efforts for the added, unique value. What is helping us is our engagement in generating epistemological pluralism relevant enough and appropriate enough for our located needs. This implies to continuously develop our understanding and practice of transformation, reality production (worldmaking), relevance and situated knowledges.

Karen Barad moves in linked epistemology fields and nurtures the development of epistemological pluralism. She argues (2003) that

> *"We" are not outside observers of the world. Nor are we simply located at particular places in the world; rather, we are part of the world in its ongoing intra-activity. This is a point Niels Bohr tried to get at in his insistence that our epistemology must take account of the fact that we are a part of that nature we seek to understand.…We are part of the world in its differential becoming.*

I want to highlight the concept of intra-activity. What Barad means is the notion of intra-activity constituting a reworking of the traditional notion of causality. She is looking for alternatives to representationalism[63] and shifts the focus from "questions of correspondence between descriptions and reality (e.g., do they mirror nature or culture?) to matters of practices / doings / actions" and bring to the forefront the issues of ontology, materiality and agency. The discursive practices and material phenomena are mutually implicated in the dynamics of intra-activity and are not ontologically or epistemologically prior (neither can be explained in terms of the other), Barad states. *Intra-activity is neither a matter of strict determinism nor constrained freedom. The future is radically open at every turn.*

[63] Compare the contexts of production and implication (Nowotny et al. 2001).

Part II

Feminist TechnoScience – trying a position

I use the concept feminist research synonymously with gender research and I use the concept feminist technoscience almost synonymously with feminist research within technology and engineering. In my academic context I still have to explain why I am defining myself as a feminist researcher. When I started in the 80s I thought it would be possible to "clean" the concept feminist researcher from all strange associations people use to make (Wahl 1996). This concept is still provoking (in Sweden) because it becomes 'political'[64] and a transforming agent in an academic discourse unwilling to transform. I should interpret this situation positively as it signals transformation of a second order (Ahrenfelt 2001), which is what I am striving for.

The feminist technoscience I am arguing for is the one not only analysing and theorizing but goes into practice and try to be transformation agents by *staying with the trouble.* (Haraway 2010)

[64] In the Swedish academic context characterized by 'the culture of no culture' the dominant epistemological approach is still to make a strong division between research and politics – an approach becoming more and more obsolete in the world we are living in.

Chapter 5

The stories told in this chapter are by no means justifying a comprehensive and fair presentation of feminist research, if that is at all possible. Feminist research is by far too widely spread academic field to be condensed into part of a chapter. I write how I have met and understood feminist research along the paths I have walked so far, how I position myself in feminist research.

Feminist Research

A statement

Feminist research is a separate scientific area of expertise with an international academic tradition of several decades. In the report The Relevance of Gender Research (Trojer 2000) it is noted that *gender research nowadays is a collective term for an extensive and rapidly growing field of research. The fact that gender can not be united in one narrow definition does not make gender research less interesting - on the contrary. There are gender researchers within all the established disciplines as well as researchers working across the conventional boundaries between the disciplines. Discipline attachment extends over medicine, engineering, natural science, humanities and social sciences.*

The interpretation of what gender research represents thus varies considerably. Both in Sweden and in the Nordic countries we find gender research in the social sciences and humanities to have a strong position[65]. My understanding comes from a technical scientific context.

One of the two general focuses in gender research / feminist research is the knowledge processes, theories and methodological approaches of science. This identification is of particular interest at a technical faculty and which is one of the main starting points for the feminist technoscience I have been involved in. The other general focus of feminist research is women / men / sex / gender / gender and power relations. However, gender and gender relations are not as self-evident as objects of study within natural science and technology as they are in, say, social science.

In the public debate about feminist research within technology as a science, gender equality issues and feminist research are often confused. The discussion is primarily about charting the reasons for the lack of female researchers (and female students) and the invisibility of their positions, and the consequences thereof. There is a movement away from the idea that feminist research entails development of special scientific skills – in my case, within engineering with a special focus on IT. Equality between men and women and feminist research are not one and the same.

[65] Maud Eduards' article "En allvarsam lek med ord" (A serious game with words) (Eduards 1995) provides an interesting interpretation of gender research within social sciences and its conceptual development.

Concept discussion

Cecilia Åsberg (1998) has reviewed the debate on the concept of gender between the year 1980 and 1998 and states that *the debate on terms and concepts and the development of feminist theory must be interpreted as an ongoing process, where the meaning of concepts and theories varies according to subject area, discipline, era and discourse. […] There is obvious pluralism in theory and application of concepts. In the second half of the 1990s, gender scientists were scarcely able to agree on a normal science. But isn't this also a sign that the science is living, where no concepts are taken as lexically granted or exempt from debate?*

Thus, Åsberg as well draws attention to the emerging practice of not fixing the concept of gender research in a general sense that can apply regardless of the discipline or field it belongs to.

At the end of the 1970s and the beginning of the 1980s, when gender research communities, primarily in the form of research centres, were starting to be established at Swedish universities, the dominant concept was *kvinnoforskning* (women's studies). The term *feminist research* that had been in use in the Anglo–American research communities had too strong an ideological bias for Swedish tastes. This term now seems to live in a parallel universe alongside more strategically viable terms. The term *könsteoretisk forskning* (gender theoratical research) has functioned fairly well at the technical colleges that have developed gender research communities.

In terms of research policy, we see that the term *gender research* started to take hold in the second half of the 1990s (for example, the government bill on research [Proposition 1996/97:5] and earlier research bills). The major Study of Power and Democracy in Sweden from the beginning of the 1990s (Swedish Government Official Report SOU:1990:44), in which Yvonne Hirdman drew attention to gender theory, probably helped the term get a firm foothold[66]. I believe that the negotiations concerning the choice of terms are probably more the result of strategic choices than assessment of the content of the terms.

Two delimitations need to be defined for feminist research within natural science and technoscience. The first one as indicated above is the importance of distinguishing between work to promote gender equality and feminist research. In order to be able to regard and understand feminist research as a scientific field of research, it must be totally clear that this is not simply work to promote gender equality. If this distinction is not made clear, feminist research risks ending up in an awkward dilemma of relevance. This is particularly the case within technoscience, where gender equality issues have tended to be all about achieving a more equal representation of women and men and equal conditions (pay, promotion opportunities, etc.) in a variety of areas within technoscience.

Early feminist critique of natural science and technology

> *We live in a world that is structured by scientific rationality and that is dysfunctional for many, many people. It is this world in which feminist thought about scientific knowledge has emerged.* (Harding 1990)

[66] See also Hirdman (1998).

The 1980s and 1990s in the Nordic countries

In this context, I am interested in the development and advancement of the feminist critique of science linked to natural science as it appeared in the 1980s and 90s. The critique started with questions regarding female and male researchers' different working conditions, then moved on to expose biased and warped research based on gender, and ended up at a more fundamental querying of the very knowledge processes used in natural science. I borrow liberally from Sandra Harding's (1986, 1987) work on the development of a feminist theory of science within natural science and technology.

In the 1980s typical questions were: Does it matter who formulates the laws of nature? Does it make any difference if it is a woman or a man, if they are rich or poor, if they are from Asia or Europe? Aren't the laws of natural science absolute, objective truths that humankind discovers, sooner or later? Feminist theories of knowledge wanted to show that it does matter who formulates the laws of nature, that gender is a central concept and indispensable for a deeper understanding of science – in this case natural science – as well as that all knowledge production is anchored contextually.

It is a question of a feminist view and critique of the history, ideological foundations and knowledge production of natural science – a feminist epistemology. Internationally, this epistemology within natural science is very young. Feminist analysis and theory within other fields of science, such as psychology, sociology, history, literature, etc. have been developing for much longer. If we define feminism as a conscious reflection on the significance of women in research and society, then it is as old as the hills. For example, there are written documents from the end of the fourteenth century, i.e. before printing was invented, available through Christine de Pizan[67].

Focusing on the Nordic countries, feminist critique of science within natural science has been around for roughly the same amount of time as elsewhere, but it has been mostly undertaken outside the traditional institutions. In the Nordic countries, this critique of science has been presented at seminars and conferences, in gender studies journals within the individual Nordic countries, in anthologies and reports (Rose 1992, Ullerstam & Vramming 1992). Feminist critique within natural science was given concrete expression in all the Nordic countries through involvement and work in FINRRAGE (Feminist International Network of Resistance to Reproductive and Genetic Engineering). FINRRAGE worked as an opinion-forming lobby network in a politically sensitive area at a time when there was no legislation on genetic engineering in most countries and when short-term economic market forces were allowed to contribute to the development of knowledge without the inconvenience of public control.

In the 1980s, Sandra Harding, professor of philosophy at the University of Delaware compiled a feminist epistemology on the basis of biology and sociology. This combination and this approach largely coincide with the development of a feminist critique of natural science in the Nordic countries. I had struggled with her publications. I knew there were important things for me and us just starting with feminist research in our mother disciplines. But it was not until I med Sandra Harding in person in the Finish forest (se introduction), I really understood her. She summarises the development of feminist critique and theory thus (Harding 1986):

[67] Christine de Pizan, The Book of the City of Ladies (1404-5), translated by Jeffrey Richards. New York: Persea, 1982.

1. Feminist empiricism
2. Feminist standpoint theory
3. Feminist postmodernism

It is the first two elements that primarily affected natural science and engineering. However, this did not mean there were not been interesting analysis tools within postmodernism and poststructuralism contributing to yield a deeper understanding with both discourse and material dimensions as well as reality-producing implications.

Women and natural science

Before the first feminist theoretical approaches were formulated, a thorough critique of science had already been done, within natural science as well as elsewhere.

The study of natural science from gender perspectives started with an investigation of women's contributions to the scientific community. There were three main focuses:

I. Famous female researchers, for example Marie Curie, Lise Meitner, Sonja Kovalevsky, Barbara McClintock. In addition to their contributions to scientific knowledge, they have much to teach us about approaches and assessments. However, through this focus on exceptional women, the contributions made by not so famous female researcher remained invisible.

II. Women's collective contribution, in the form of actions in different movements, such as environmental movements, civil-rights organisations, peace movements and other historically acknowledged movements.

III. Misery research (i.e. research into women as victims) for example issues of power relations, the exclusion of women from academia.

All three focuses have been important in the early developmental phase. They drew attention to the conditions in which female researchers worked and the consequences they had for their contribution to the advancement of knowledge. However, this work had its limitations and did not go far enough. The problem here was and still is that they leave men at the centre of knowledge. It is always a case of women in a men's world.

Astrid Cleve von Euler illustrates a female researcher's situation in a male-dominated research world that ended up in exclusion[68]. She came from Uppsala and lived from 1875 to 1968.

Astrid Cleve was the first woman in Sweden to get a doctorate (1898) in natural science and the third woman to get a doctorate in any field. Astrid Cleve was only 23 years old when she defended her thesis on Swedish mountain vegetation (studies of the growth time and strengthening stage of a selection of Swedish plants). This thesis was unlike any other botanical research at the time, when interest in classification and morphology was dominant. Astrid Cleve's studies were one of the first to emphasise growth physiology and biochemical aspects. Her academic background was in biology and chemistry. She was the eldest daughter of the famous chemistry professor in Uppsala, P.T. Cleve.

[68] I am grateful to Sif Johansson, who introduced me to Astrid Cleve, when I was looking for an early female role model in chemistry preferably in Sweden. For more information about Astrid Cleve please see Johansson (1983).

Most of her life she was forced to do her research outside the established research community, focusing on diatoms (siliceous algae). Her best known and most widely recognised contribution to science is a five-volume diatom flora, which was published at the beginning of the 1950s. For a long time, that was the only complete flora containing both current and fossilised forms and is still highly sought after by researchers around the world. Astrid Cleve was honoured with the title of professor in 1955 for her work on diatoms.

Analyses of diatoms are an important tool in quaternary geology. Astrid Cleve was highly respected by researchers in this discipline. She became interested in quaternary geology herself, and the development of the Baltic Sea in particular. The results of her research led to theories, which in many ways broke with theories in quaternary geology, but which became valid areas of research. Her views are being afforded ever more value.

Astrid Cleve's scientific career is very different from her husband's and one of her sons', despite the fact that the scientific starting points were identical. The men in question were awarded a Nobel prize each.

Feminist empiricism

The feminist critique of science continued to evolve and reached the first epistemological approach, as defined by Sandra Harding.

Feminist empiricism grew out of liberal feminism and claims that androcentrism is a social distortion that can be corrected by adhering more closely to existing methodological norms in scientific studies.

There are numerous examples in biology of studies only using male animals (this also applies to humans) and yet still draw conclusions for the whole species. One of the arguments for this practice is the females' hormone cycles disrupt the findings.

The normal values used in medicine are often based on values from men, for example, young men doing military service. This has led to women being given the wrong treatment, for example in connection with high blood pressure and heart attack. Much of the vast amount of research that has been done on the brain since the beginning of the 1900 has looked for and claimed to have found physiological differences between men and women's brains (Sayers 1982, Walsh 1979). These studies have provided biological arguments for the inferiority of women. Ruth Bleier, a neurological researcher, has shown how below-par studies and warped interpretations of results has continued to be published (Bleier 1991).

According to Harding, the women's liberation movement not only created opportunities for broader perspectives on the view of reality, but also prepared the ground for more female researchers. According to feminist empiricism, they are more inclined to recognise androcentric prejudices.

However, feminist empiricism does not query the logic of the research process and the existing methodological norms of science. It is easier to gain sympathy for feminist demands through this way of arguing. It identifies only "bad science" as a problem. It does not criticise normal, general science.

Scientific method is thus not problematized, rather it is assumed that it is capable of eliminating all prejudices and distortions arising from the fact that individual researchers have different origins,

different nationalities and different sexes. Feminist empiricism includes the view that women (or rather, feminists, who can be men or women) as a group are more likely to produce prejudice-free, objective results than men (or non-feminists) as a group.

It may appear that feminist empiricism is permeated by a conservative approach as not querying scientific logic and its methods. But by adding women and thus social / cultural gender, it can become radical. In discussions of scientific theory, men and the role they play in science are also studied. Simone de Beauvoir (1949) stated that "Women are made not born". This probably also applies to men "Men too are made not born". So, what consequences does this have in male-dominated sciences like the natural sciences and engineering?

Feminist standpoint theory

Investigating the significance of the gender and social identity of researchers entails a pervasive querying of the basic values and consequences of science. To this end, feminist empiricism is inadequate as an analysis model and epistemological approach. This is where feminist standpoint theory takes over.

Sandra Harding introduced this theory and made it generally known. It was then primarily developed by the Canadian sociologist Dorothy Smith (1987, 1990). Dorothy Smith presented her standpoint ideas more as a method for thinking than as a finished theory. This analysis model uses a standpoint, which starts in women's reality – women's everyday lives. Theories, terms, concepts and knowledge are created from practical and bodily experiences from daily (and nightly) life.

Harding believes that feminist standpoint theory ideologically is rooted in Hegel's theories of the relations between the master and the slave. The main thesis is that the starting point of oppressed groups (the proletariat) provides a truer picture of reality and they therefore have less to lose by adhering to a less warped description of reality than groups with power. Consequently, women, as an oppressed group, ought to provide a less distorted view of reality with their knowledge and experiences.

Harding holds feminism and women's movements to develop theories and motivation for research and political reform able to transform women's perspectives to a standpoint. This standpoint is a basis, which is socially and scientifically preferable for our interpretations and explanations. A science using women's lives as its starting point poses different questions and ascribes priority to other types of knowledge and understanding.

The problem here is that we cannot find a general female identity to build our theories on. Harding claims feminism to make an important contribution, by showing there is no such thing as a generally applicable human being – only women and men who live in complex patterns of class and with racial and cultural identities.

However, just because the picture gets complicated does not mean it is not interesting to apply feminist standpoint theory. On the contrary, it is particularly interesting in natural science and technology today for several reasons. Here, gender researchers have tried to look beyond the formation of theories and see lines of development created at specific historical times and in special social circumstances – always with a starting point in women's lives and experiences. Much work

has been done to identify the origins of today's natural science, with the main emphasis on the scientific revolution. By studying the history of science, we see how ethical judgements change and create conditions necessary for a scientific and technical rationality, which today seems far too destructive, from a global perspective. The study also provides explanations for the almost total lack of women in processes of knowledge during the basic development of natural science.

Alternative to the Master-Slave dialectic

As the feminist critique of science emerged and created explanatory models, a need also grew for alternative images to counteract the negative and destructive side of the science coin. Evelyn Fox Keller, a mathematical biophysicist and philosopher of science, has described several existing theories in natural science permeated by a clear master ideology (Keller 1985). She has also provided examples of counter-images to contrast these "master theories". These ideas are most clearly developed in her biography of the geneticist Barbara McClintock – winner of the Nobel Prize in Medicine in 1983 (Keller 1983).

McClintock's scientific work contains non-hierarchical theories offering an alternative to the master ideology. Instead, priority is given to the absolute necessity of interaction to understand complex genetic functions and, in a longer perspective, evolution, whose judgemental character McClintock criticised harshly.

A driving force in the formation of theories within natural science is reducing as much knowledge as possible to a few simple, generally applicable laws (se chapter 1). This has great status value and is also held up as beautiful and pleasing. The central dogma within genetics is one such simple, overarching law, aiming to show how the function of the genes is decided. This dogma is, according to Keller, a typical example of a master theory, which Barbara McClintock opposed ever since it was first developed in Watson and Crick's 1953 publication. The central dogma, i.e. the primordial controlling function of the DNA molecule over the RNA molecules to form protein, gives DNA a central role in the organisation of cells. The dogma describes a one-way communication that was regarded as a condition for genetic stability.

McClintock showed that DNA molecules are not always so static in their make-up and organisation. DNA segments can move – the so called jumping genes or transposons – causing significant changes in the DNA molecule. An image of a highly complex genetic organisation began to emerge. McClintock believed there is no such thing as a superior molecule, rather it is more a case of an alternating flow of information in complicated regulatory mechanisms. This interaction between DNA molecules and not only cells, organs, entire organisms, but also the environment outside the organism entails more and different knowledge about organisms' adaptation to the ecosystem and which is finding its way into present gene related research.

We can regard Barbara McClintock's research results as a complement to the central dogma – as do many scientists. McClintock herself believed we are in the middle of a revolution that will change our approach. Her feeling for nature and organisms, her way of relating and her research methods prepare the ground for a basis for assessment that needs to replace the foundations on which today's natural science is built – the natural science encountering challenges of earth survival.

Feminist postmodernism and poststructuralist strategies

In philosophical terms, postmodernism entailed abandoning the major "projects" of modernity. Feminist postmodernism directs general criticism at theories that use universal claims and demands (Barrett 1992). It criticises the feminism of the 1970s, which developed universal demands of this kind. The debate we have seen in postmodernism is part of a broader criticism of today's thought systems with their universal characteristics.

Postmodernism includes a criticism of rationalism as a doctrine and the impacts it has had for the human subject and different forms of subjectivity. It includes redefinitions of structures and terms – even for the gender structures fundamental to feminism. A critical question for feminist analysis is whether it is possible to give up the culture and discourse in which feminism's identification and criticism of gender were created and in which feminism has located its major reforms. Another critical question is how and whether the lost terms (within feminist postmodernism) can be filled or recreated.

Harding (1991) holds that both feminist standpoint theory and postmodernism assume an ambivalent attitude towards the basic assumption of Enlightenment. They adhere to the idea that social progress is desirable and possible and that refining theories about ourselves and our surroundings will contribute to this improvement.

Within postmodernism and poststructuralism, the significance of language has assumed a central role. Hierarchical descriptive models using power metaphors show how language and symbols are fundamental even within the formation of theories within natural science. French feminism, which pioneered the development of feminist postmodernism, has been particularly interested in the relevance of language.

The French philosopher Julia Kristeva has contributed to a deeper understanding of the significance of language in connection with the feminist critique of science. She has studied the problem of how meaning is created and how the speaking subject reproduces itself (Moi 1985). Kristeva coined the term intertextuality to show how one or more systems of signs are redistributed among each other. Within these systems, different political and power-relating interests are expressed, which cross one another in characters and symbols. Although we can claim that a dominant power group at a given time dominates the intertextual creation of meanings, this does not mean that the oppressed group has been reduced to total silence. The power struggle is visible in the signs.

Julia Kristeva has also studied the function of poetic language. It is primarily in poetic texts, Kristeva claims, that the speaking being's troubles and joys are expressed. For example, a dictatorial society cannot exist unless it kills poetic language, which says too much about people's real needs. Kristeva claims that "the function of poetic language is to destroy and reconstruct social compulsion. This kind of task requires transforming the entire critical apparatus and the traditional terms and concepts, since the methods of classical thought privilege moments of stability and not crisis, whenever meaning is to be determined. Poetic language, by contrast, articulates what is unspoken and suppressed." (Kristeva 1974 tolkad av Witt Brattström 1984)

The linguistic turn in feminist research was later on balanced in new materialism e.g. by Karen Barad (2007).

I learned a lot from Sandra Harding's introduction to feminist epistemology and its different

stages, which are not only to follow a strict time scale but to experience in parallel. To make partial translations into the context of technology has made sense and constituted a platform to vision epistemological infrastructures beyond Harding's and relevant for knowledge production and technical development in the challenging academic situations I have moved into.

It might be obvious by now and from chapter 4, that I have found the strongest potentials for my epistemological thinking in feminist poststructuralism as it has been developed by Donna Haraway. How this has evolved is intensely linked to my location as a researcher in technoscience since the beginning of the 90s and will be further discussed in the next chapter.

But I will not forget Julia Kristeva and her contribution to poststructuralism important for social transformations including the knowledge producing bodies of society. AGORA[69] highlighted the work of Kristeva again in 2003 in a special volume (nr1/2003). I was reminded of the close link between Kristeva's intertextuality and poststructuralism (Winderen Owesen 2003) and how the texts (for knowledge production) communicates in a polylogue, a polyphony of non hierarchical voices. We produce knowledge in a net of discourses without a centre I would say using the work of Dorthe Gert Simonsen in her paper about poststructuralist strategies from 1996. Simonsen comments the significance of intertextuality by stating that *it is a continuously motion and displacement in every unit of signification because of the never ending reference to something else like the text or the sign quotes or put itself in opposition to, in order to make sense.*

When referring to our complex processes of knowledge production in technoscience, Paul Cilliers add potentials in poststructuralism by summing his arguments in a study of complex systems. He writes (1998 p 37) *Since it (complexity) is based on a system of relationships, the poststructural inquiry into the nature of language helps us to theorise about the dynamics of the interaction in complex systems. In other words, the dynamics that generates meaning in language can be used to describe the dynamics of complex systems in general.*

Simonsen is very clear about poststructuralism to be critical strategies not a fixed –ism, a joint concept for different critical strategies active at numerous levels. Its strong potentials are located in the tryings to avoid to legitimize knowledge by universalizing. Another Danish feminist researcher Dorte Marie Søndergaard (2002) confirms Simonsen's understanding by claiming that *perhaps the most radical claim of poststructuralism is to reject the possibility of arriving at a "truth" about the essence of a phenomenon.*

[69] Journal for Metafysisk Spekulasjon (for metaphysical speculation)

Chapter 6

To be in processes of evolving feminist technoscience within technically oriented disciplines is a collective effort. The daily life of these efforts have for me signified cooperation with PhD students, undergraduate students, research colleagues, teacher colleagues, staff members in different positions. Without them, no feminist technoscience in reality. In this chapter I can be read as harsh on academic communities focusing on studies (only) at the same time as I appreciate a lot of work done within these spheres. I want to see the feminist technoscience I am arguing for as working in realities as well as contribution to the academic field of technoscience.

Feminist TechnoScience

Within faculties of technology

The history of feminist technoscience situated at faculties of technology and engineering has proceeded from the practice of counting heads (how many women) to fostering and advancing understandings and practices of knowledge production. This is not a linear process but more of a process in parallel. The gender equality work continues and is still far from reaching its goal in sustainable 40/60 % representation at all levels. The academic story in Sweden within a time frame of more than 3 decades shows that we have moved from the gender equality question, over the woman question[70] to the science question. This is referring to the Harding turn (Harding 1991) moving from the question what science can do for women to what feminists can do for science. There are no simple or self-acting links between these general phases.

During these decades we have emphatically argued for the importance of perspectives from within (Trojer 2002). This is a central condition for feminist technoscience to be relevant and used at faculties of technology and engineering. Karen Barad has fostered this argument. She writes (Barad 2003, p. 828) that *on an agential realist account of technoscientific practices, the "knower" does not stand in a relation of absolute externality to the natural world being investigated—there is no such exterior observational point.* It is not enough to make gender research studies of technology from outside. It is equally important to be deeply involved in "the belly of the beast", a belly you are passionately interested in (Haraway 1991).

I persist to appreciate Haraway's (1997a) statement that *Technology is not neutral. We're inside what we make, and it's inside us. We're living in a world of connections – and it matters which ones get made and unmade.* This citation was put up on the wall in the lunchroom at a research laboratory focusing water jet technologies close to BTH. Together with a colleague we were hired

[70] e.g. developing cars or speech synthesizer suitable for bodies of women.

to integrate some kind of gender research perspective in a EU project at the laboratory mentioned. The Haraway citation was almost impossible to comprehend for the water jet researchers in our introductory discussions. But some of them took the initiative to copy it and put it on the wall in the lunch room for further internal debates. Almost a year after this event, we came back for continued collaboration and found the involved researchers appreciating the citation and all the discussions it had nurtured.

A statement

Technoscience is a concept frequently used by Donna Haraway. She holds that despite all the hype, technoscience as an overarching theme is not the greatest story ever told, but *it is playing powerfully to large, widely distributed audiences* (Haraway 1997b, p 4). She stresses that *the world-building alliances of humans and nonhumans in technoscience shape subjects and objects, subjectivity and objectivity; action and passion, inside and outside in ways that enfeeble other modes of speaking about science and technology: In short, technoscience is about worldly, materialized, signifying and significant power* (Haraway 1997b, p 51).

One characteristic of technoscience is, as Gulbrandsen in Gulbrandsen et al. (2006) is emphasizing, the reverse logic – knowledge has to be used in order to be tested. A classic example is reproduction technologies[71]. In feminist technoscience the research political discussion is thus vital about the relation between research and politics, i.e. the reality producing aspect of science and research.

Engineering science is characterised by classifications, standardisations and formalisations within a frame of general consensus. Bowker and Star (1999 p 10-11) describe the phenomena and practice of classification: *A classification is a spatial, temporal and spatio-temporal segmentation of the world. A 'classification system' is a set of boxes (metaphorical or literal) into which things [we would like to add: people] can be put to then do some kind of work – bureaucratic or knowledge production…Classifications are consistent and unique, mutually exclusive and complete.* Feminist technoscience is especially engaged in studying this basis and developing new ways of approaching the core of knowledge production, in order to strengthen the ability of science to bring about change. This research has made an impact by showing the type of understandings of knowledge, science and technology that dominates and has consequences in terms of creating realities. Internationally, feminist technoscience provides an epistemological infrastructure for a variety of choices and decisions in our societies increasingly dependent on research and technology. This research is thus no longer about simply drawing attention to the perspectives, experiences and needs of women.

Within the tradition in feminist technoscience developed in Sweden and internationally, the growth of theories represents a complex and extensive knowledge process of an interdisciplinary and transdisciplinary nature. This entails my academic working environment not only consisting of researcher colleagues from a variety of different, more established disciplines, but also of researcher developing an epistemological competence for the inter- and transdisciplinary research that she or he is pursuing as well as other knowledge producers outside the academy.

[71] from in-vitro fertilization to cloning see e.g. www.finrrage.org

Outside versus within

For a number of years, studies with a gender perspective in a number of fields (sociology, economics, history, pedagogy, labour organisation, to name but a few) that have made technology the object of research have attracted attention. What distinguishes this research is that women, gender and gender–power relations are the focus of the research, not the formation of technoscientific knowledge itself. This research is thus marked by an outsider perspective in relation to technology and lies outside the bounds of gender research within technoscience.

The field of science and technology studies (STS) is an example of research in social science and the humanities where technology, natural science and the relations between technology, natural science and society constitute the "study object". It is interesting to note that feminist STS has existed throughout the whole development of the STS field. STS is a central and important research field that helps identify problems – for example how traditional gender stereotypes colour the way we think and act, even in our relationship with technoscience and its products. Nevertheless, there is a long way to go before this research is at the forefront of concrete technological development. Although feminist science and technology studies (feminist STS) has been and still is dominated by social scientists, stronger alliances have also been formed with humanists, natural scientists and technologists.

The technoscientific insider perspective does not prevent the communities that have been created for technoscientific gender research at technical faculties recruiting researchers with very divergent disciplinary backgrounds. In addition to civil engineers and technologists, there are many humanists and social scientists. Together these researchers create viable, productive interdisciplinary groups.

The research focus

Previously, I have stated that feminist research within technoscience tends to study technoscience in its own right – its theories, methods, knowledge processes and practices – as opposed to women, gender and gender power relations (Trojer 2000, p.7). This displacement of the focus – away from women and gender issues, and towards the very theoretical and methodological fundament of the discipline itself – is not unique to feminist technoscience research. For example, within corporate economics, gender research has led to development of overarching organisation theories (Wahl, 1996, 1997).

What probably distinguishes feminist research within technoscience from other feminist research is that it moves on from the study of gender fairly quickly. Advanced technical research around and development of speech synthesis for women operated for throat cancer is not, for example, a study object of gender research. Research of this kind is more a low-priority part of normal science (which has focused on developing speech synthesis for men). This type of research is usually called addition research. The researcher adds the category "women" to existing research. Within medicine, addition research has led to controversial negotiations between established research and gender research, as well as between different orientations in medical gender research.

A radical transformation project

A common trait of all feminist research is the ambition to transform research. In many ways, this is an obvious starting point. From the outset, it was deficiencies and distortions in established research that motivated feminist researchers. New feminist research thus comprises a criticism of science. If we regard the issue from an international perspective, we are dealing with an increasingly radical[72] reform project (Trojer, 2000).

The research-reforming work that feminist technoscientific gender research has done has certain fundamental starting points. For example, it is not enough for a researcher to discover and chart an existing reality that was waiting "out there" to be discovered (context of discovery) (see chapter 4). Research must also focus on what Elisabeth Gulbrandsen calls the context of production. She (Gulbrandsen 1993) writes *we cannot only resolve the problem 'out there'. Our knowledge-producing activity is in itself a (re)productive force. We are not situated outside a civilisation form that has become problematic. We are implicated in it.*

A major challenge for us then as researchers is to regard ourselves not only as producers of solutions and improvements, but also as part of the problem. Gulbrandsen underlines the reality-producing nature of research.

One challenge for technoscience is how to meet demands like theoretical and methodological openness, which Ina Wagner (1994) has formulated in some methodological principals, namely to:

- include models and procedures that can develop the complexity in natural systems (learning and research processes)
- accept epistemological pluralism (the validity of multiple ways of producing knowledge and developing praxis)
- define ways of translating / bridging / linking the many developments of theory
- overcome the barriers created by artificially isolated scientific questions.

In radical transformation processes you need visions for a preferred future. It is extremely difficult to get out of your fixed mindset and figure what that would be. A helping hand is to use figurations and one of the most profound ones in feminist technoscience given by Donna Haraway is the cyborg. Haraway explained in Markussen, Olesen, Lykke (2000 p 7, 11) that

> *The cyborg was a figure that collected up many things, among them the way that post-World War II technoscientific cultures were deeply shaped by information sciences and biological sciences, by the implosion of informatics and biologics that were already well under way by the end of World War II, and that has only deepened in the last 50 years and transformed conditions of life. These are no matters of choice, neither are they matters of determinism. These are deep materializations of very complex socio-technical relations…..It is neither technophobic, nor technophilic, but about trying to inquire*

[72] I am using the term radical in its original sense (fundamental, arising from the root) and in its chemical sense (highly changeable).

> *critically into the worldliness of technoscience. It is about exploring where real people are in the material semiotic systems of technoscience and what kinds of accountability, responsibility, pleasure, work, play are engaged and should be engaged.*

Agent of change

If research of technology and the researchers' positions are being renegotiated and relocated, the self-critical question reads: Can the feminist technoscientific research be a reliable agent of change in the arenas where alliances are not given and / or secured, but the contrary where no sympathies or successes can guaranteed? Donna Haraway's (2003, p. 7) simple but still difficult answer is:

> *Answers to these questions can only be put together in emergent practices; i.e, in vulnerable on-the-ground work that cobbles together non-harmonious agencies and ways of living that are accountable both to their disparate inherited histories and to their barely possible but absolutely necessary joint futures.*

Haraway's message thus says that the epistemological, methodological and empirical fields of practice are not owned by a group of researchers in academia with the privilege of being alone to define goals or means. Disparate experiences, skills and stories meet. Patience and work are required for something new to emerge out of the asymmetries. However, what unites all the actors is a desire for a sustainable future, which can only be created in association with others. Or again with Donna Haraway's (1991) words, what is needed, required and what we dream of is "…an earth wide network of connections, including the ability partially to translate knowledges among very different…communities".

Part III

Research Politics

Not only Donna Haraway but scholars like Sheila Jasanoff, Sharon Traweek and Elisabeth Gulbrandsen are convincing in their arguments about research as reality producing / world producing activities. Science is (co-)creating society and is thus political. That is why I am emphasizing also researchers to bother about the political dimensions of their research. As a scientist I have to see myself as producer of realities for myself and for all others in society. If you find this statement too abstract just think of a medical or ICT researcher. Explicit mode 1[73] researchers are often provoked by this approach denying the dominant epistemology of neutrality and objectivity as well as discarding the God trick[74] (Haraway 1991 p.189).

Wendy Hollway (1989) states that *science as we know it could only become dominant because it was preferred*, and being preferred means strong involvement in political issues.

Before going deeper into this co-constructions of research and politics, the following three chapters concerns a quite unique research political situation in Sweden concerning support to interdisciplinary and feminist research.

[73] Gibbons et al 1994

[74] *God-trick of seeing everything from nowhere*

Chapter 7

During the 90's a window for specific research politics opened, which both acknowledged the social relevance of research and thus captured a more inclusive approach. This benefited not only interdisciplinary research but also feminist research and in addition a distribution of academic institutions regionally in Sweden. This chapter concerns the research political motions during this exciting decade of the 1990. A number of research bills have been submitted since these of the 90s, but none of them has shown the kind of explicit link between research and politics as the one presented in this chapter.

Diffractions in Research Political Tendencies[75]

> *Science does not enter a chaotic society to put order into it anymore, to simplify its composition, and to put an end to its controversies, It does enter it, but to add new, uncertain ingredients to all the other ingredients that make up the collective experiments. When scientists add their findings to the mix, they do not put an end to the politics; they add new ingredients to the collective process.* (Latour 1998)

The late-modern era

If we try to analyse how and where research and knowledge production is being done, it seems many of us are working in a late-modern society. Some people are even beginning to talk about postmodern research organisations (Smith, Webster 1997). I am going to discuss a number of tendencies in contemporary knowledge production and their research-policy context. I am particularly interested in understanding how the relationship between research and politics, i.e. research's social contract, appeared in the 1990s, when, for example, information technology became a highly dominant area of knowledge and technology development. Using a number of research policy documents and drawing on a number of well-informed researchers, I am going to point out some dominant characteristics of the "contract negotiations", which were hard and bore a closer resemblance to the powerful oscillation of a pendulum than a clear linear movement. But first

[75] This text was part of a lecture series "The Role of the University in Society" spring 2000. Responsible for the lecture series was the Research Board at Blekinge Institute of Technology.

Some concepts

Knowledge production

A good friend and highly respected professor within the hardcore of natural science reacted strongly when I used the term "knowledge production". He wondered what had become of the pure, beautiful discovery of concealed truths with this kind of terminology. I myself was schooled in this highly stable, Popperian knowledge tradition. It is disquieting when people like me very gently suggest that tendencies in this knowledge tradition are a form of paradigm blindness. As a concept, knowledge production suggests problematisation of where and how knowledge is generated in our society. My view of knowledge and research processes is based on a far more complex problematisation found in parts of feminist research and in other knowledge-reflecting schools (for the most part, poststructuralist streams of understanding). Hence my choice of terms. The vision of purity and orthodoxy are the distinguishing features of the modern project (Liedman 1997). Purity of doctrine is linked to the orthodoxies in science. As Georg Henrik von Wright points out, each science can be said to build on certain orthodoxies, which cannot be queried when the quality of the ongoing research is being assessed. Orthodoxies are necessary to ensure that research does not end up in chaos. But von Wright also believes that *great progress, the events that make the history of science such a dramatic and exciting chapter in the biography of the cultures, occurs when the 'purity of the doctrine' is queried and the 'unbelievers' triumph. For this reason, it is never in the interest of science that orthodoxies are confirmed, rather the opposite, that they are doubted …* (von Wright 1986, p. 126).

Diffraction

I prefer to use the term diffraction instead of reflection, perhaps partly to cause readers to raise their eyebrows, but mostly to follow Donna Haraway. Diffraction is a metaphor for efforts to make a difference in the world. Allow me to quote a passage that explains my preference.

> *My invented category of semantics, diffractions, takes advantage of the optical metaphors and instruments that are so common in Western philosophy and science. Reflexivity has been much recommended as a critical practice, but my suspicion is that reflexivity, like reflection, only displaces the same elsewhere, setting up the worries about copy and original and the search for the authentic and really real. Reflexivity is a bad trope for escaping the false choice between realism and relativism in thinking about strong objectivity and situated knowledges in technoscientific knowledge. What we need is to make a difference in material-semiotic apparatuses, to diffract the rays of technoscience so that we can get more promising interference patterns on the recording films of our lives and bodies. Diffraction is an optical metaphor for the effort to make a difference in the world.* (Haraway 1997b, p 16)

Knowledge production in late-modern social change

The forms of production of knowledge have gradually changed since the Second World War. In the first phase, active knowledge policy allowed realisation of the possibility of promoting

social renewal and strengthening the economy's driving forces through technological and scientific research. Although many branches of science have had a strong international basis, the continual strengthening of the internationalisation of research can be regarded as a long-term and indisputable trend.

This was the argument of the Swedish Council for Planning and Co-ordination of Research (FRN) in its strategic analysis of Swedish research at the end of 1999[76].

FRN pointed out that an important tendency in the reform of the knowledge system is the increase in the number of knowledge actors outside academia. This poses new international and financial requirements, not least regarding processes related to formulating problems, participation, transparency throughout the entire research chain and active mechanisms for transfer of knowledge. It also lays down requirements for the presence of the critical function that social science and the humanities can provide. At the same time, the new constellations of actors entail different, new collaboration for research support and choice of direction. Whether we sympathise with this tendency or not, we can observe an increase in the rate at which different knowledge-producing alliances are formed. They are increasingly set up as projects that organise knowledge to resolve specific identified problems. One of the tendencies of the contemporary era appears to be a web of constantly changing projects carried out within the framework of new types of platforms for ad-hoc knowledge production.

FRN noted that when companies attempt to describe the value of their knowledge processes, they talk about intellectual capital and intangible assets. Herein lies a fundamental distinction between creating value from trade in material goods and creating value from trade in intangible services. In the former case, goods change hands against economic compensation and the buyer ends up with the item, but not the underlying knowledge process. The seller loses the goods, but keeps the process. In the latter case, value is created through the seller sharing the knowledge process itself. In this case, both the buyer and the seller gain access to the knowledge process and are given the opportunity to develop and further increase the value together through joint activities.

Many of the major challenges facing society today require understanding of complex systems - how they are conceived, developed, governed and form explicit or implicit value structures. It applies to our technical / organisational infrastructures, for example within communication, energy supply, the food industry and also to more abstract systems like the way our daily experience of events is shaped by the media. In many cases, complexity is related to a potential vulnerability and risk. Developing understanding of complex patterns requires substantial effort, also in terms of method. Of course, different understandings of knowledge must be mobilised to interpret the complexity of human – non human (machine) interactions of various kinds or the complexity of the system of trust that allows us to co-exist in multi-ethnic societies.

I entered a a research conference in 2000 in Denmark[77], where the role of universities in a late-modern society was discussed. The central themes were university structures, knowledge production and gender constructions, where academic knowledge production was perceived as distributed well

[76] Dnr 1999-0843:2

[77] Research conference "University structures, knowledge production and gender constructions", Copenhagen 2–3 March 2000, financed by six Danish research councils.

beyond traditional borders. Main topics of discussion were the contextualisation and fragmentation of knowledge production, erosion of an epistemological core (ontic dumping) and the results of academic work as instrumental products or intellectual processes. The following challenging questions were formulated.

If a new concept of knowledge, which is partial and fragmented, is gradually appearing within parts of the knowledge-generating Western universities, and Western societies are turning into 'knowledge societies' (i.e. increasingly dependent on research and technology) how are we to understand

1. the privileged position of partial perspectives on knowledge at the late-modern universities,
2. the epistemic culture of expert knowledge systems, which is being built up within and outside (but still linked to) universities; and
3. the consequences of new technologies for knowledge production in general and within universities in particular?

How are we to understand knowledge production in light of the access of formally marginalised groups (read: women and immigrants) to participate in power definitions / preferential interpretations and the simultaneous restructuring of the institutions? More specifically, what should we think of the potential difference that integration of these groups into the institutions and knowledge productions would generate?

By way of a summary, we can see that late-modern social change has challenged the organisational constraints and principles for Western universities. The guarantee of life-long qualifications, the authority of research and scientific knowledge and the idea of universities as a source of enlightenment and truth have been made the subject of debate on a cultural and institutional level. Western universities have become mass institutions and their authority has been queried. In these shifting circumstances, we can ask what will be the stamp of approval for knowledge production in the future and how are the institutional structures going to be organised? How are we to understand the processes of change and which visions can be developed, if the future institutions of higher education are given these new conditions and challenges?

The contract discussion

The fields of science currently most obviously challenging the boundaries between research and politics, between science and society are primarily the new technological areas of information and communication technology, biotechnology and nano technology. We see how "negotiations" are taking place to determine the role of research in society, which can be expressed in terms of research's social contract. By no means are these negotiations a purely modern or late-modern undertaking, rather they have been going on for centuries. The negotiating institutions have been religious, governmental, private and commercial institutions.

Gro Hanne Aas (1999) stated that using the concept of a contract is one way of developing relevant and more complex understandings of the relationship between science and society in an era that

requires a different kind of accountability than was acceptable in the past. Her starting point was the Norwegian official study "Organisation for holism and diversity in Norwegian research"[78] (a.k.a. the Grøholt report), which resulted in a major reform of the research council in 1993. It was this report that launched the idea of a contract between science and society in Norway. It pointed out the old contract, when science enjoyed an elevated position and indisputable legitimacy, is no longer to be applicable. Now we are trying to negotiate a new contract, which cannot rest on the old truths and matters of course. The negotiations start from different requirements regarding research from parts of society outside the academic institutions. These requirements may relate to ethics, legitimacy and cost awareness. Research has to accept that it must be accountable in a new way, according to the Norwegian research report.

The contract between research and politics in modern Western societies is thus in a period marked by turbulence and substantial change. I interpret feminist research as one of many catalysts in this process. During his term as Minister of Education, Carl Tham raised the question of the political content of science, thus marking a turn in the official argument, which is of central importance, even for feminist research. Carl Tham focused on certain cases of science being steered towards social goals and, as cited in the introduction, drew attention to a number of them at the Swedish Council for Planning and Co-ordination of Research's Breakpoint Conference on 15 March 1995[79].

> *My questions are directed at the science community, which has great influence and therefore is also basically political in its nature. Why have we failed to give science better social control? Is it reasonable to accept that technology is exclusively determined by the market? Can we find public support for a research policy that not only takes our immediate needs into account, but that also actually makes a contribution towards dealing with humankind's problems? Is it not basically this that is demanded of us? Should we not formulate a policy of hope?*

Research policy movements

> *The main research-policy questions of the 1990s have been whether research resources are being used efficiently and whether society is getting an adequate return on its investments in research. The problem is whether it is even possible to answer the latter question – and if it is, then who is to pass judgement? Uncertainty keeps on forcing us to ask new questions about how society's research resources are to be directed, managed and coordinated to counteract the interscientific needs of research and society's desire for research results.*

Bertel Ståhle (1996) describes the situation thus in a Swedish Government Official Report[80] on the research-policy landscape in the Nordic countries in the 1990s. The Official Report forms part of the

[78] Official Norwegian Report NOU 1991:24

[79] Published in the Swedish Council for Planning and Co-ordination of Research's journal FRN nytt no. 2, 1995

[80] 1996:28

research funding report[81], that was led by Susanne Eberstein and was one of the starting points for the research bill "Research and society"[82].

Before I start commenting on the various research bills that were presented in Sweden in the 1990s, I would like to present some more general features of Swedish research policy during recent decades by quoting Bertel Ståhle from the same report. He claims that there are several special features in the development of research policy that support the claim that research policy in the middle of the 1990s was in a new phase deviating from the main lines characterising the research systems in the OECD countries in previous "research policy periods". From the Second World War until the beginning of the 1960s, the main goal was to build up research institutions, and research was an end in its own right. However, research was mostly into nuclear physics and nuclear power, military research, outer space and more general 'big science' focusing on priorities in the major industrial countries. In the early 1960s, voices started emphasising the role education, research and technology play in the economic development of society. Towards the end of the 1960s, there was a stagnation in the development of resources. In the 1970s, research policy was dominated by the view that research could resolve all of society's problems. Research was supposed to be a useful tool in social policy and improve the environment, health, social welfare and quality of life. Sectoral research was the new in-thing, and the decade was marked by applied research governed by society and focused on specific sectors. The social relevance of research was emphasised in quality criteria, which in turn gave rise to tensions between the various different actors in the research system. During the 1980s, research policy became increasingly oriented towards technology and innovation. A boom in research programs was recognized. R&D was regarded as an important factor for Sweden in the international market competition.

So, what was the dominant research policy in the 1990s? According to Bertil Ståhle, research policy in the 1990s focused heavily on the actual R&D system itself, the political organisation of research (perhaps more so in Norway than in Sweden) and research-policy instruments. There was a call for simplification, transparency, flexibility and planning. Research policy was peppered with terms such as management by objectives and results, strategic research, program allocations, national coordination and national research strategies. Basic research and applied research were increasingly integrated – as we have seen first hand in technoscience. There were ever stronger signals about the need to bridge traditional boundaries between domains and disciplines. Prestige words included quality, effectiveness, efficiency, relevance and usefulness. Means proposed to achieve these ends included prioritisation, specialisation and concentration, competition between researchers and groups of researchers for research resources on commercial "market conditions", post-graduate study and internationalisation.

Whereas research policy in the 1970s was egalitarian and nationalised, research policy in the 1990s was more elitist – quality and relevance were the most important indicators of competitiveness - spearhead research in an international context was given priority.

Hans Landberg (2000, pp.14, 15, 21) studied Swedish research policy in the 1990s, finding an increased focus on application-oriented research and a shift towards a sectoral orientation. This was mainly

[81] Forskning och Pengar [Research and money] SOU 1996:29

[82] Prop. 1996/97:5

a result of EU research programs and the formation of the research foundations in Sweden, but was partly also due to changes in the balance of power between research-funding authorities (for example between the Swedish Natural Science Council NFR and the Swedish Agency for Economic and Regional Growth NUTEK, between the Swedish Research Council for the Humanities and Social Sciences and the Bank of Sweden Fund, and between the Swedish Environmental Protection Agency and the Swedish Foundation for Strategic Environmental Research). Powerful counter-reactions developed within the established research world, which were most clearly manifested in the government report "Research 2000"[83] published in autumn 1998. The counter-reaction took the form of a head-on attack on sectoral research. The government report proposed that the substantial subsidies allocated to sectoral research should be transferred to research councils, which were regarded as oriented towards disciplines and governed by researchers.

Landgren points out that the most momentous change in Swedish research policy in the 1990s was the investments in small and medium-sized colleges. There was a major breakthrough in 1995 when the government decided that small colleges should be given fixed resources for research. *Thus, the genie was released from the bottle and, with the government as a strong driving force, the development has accelerated faster than most people expected: on 1 July 1999, the colleges in Karlstad, Växjö and Örebro were given university status.* Add to that the Blekinge Institute of technology was given a technical faculty, i.e. university status within technology. Despite the fact that they have far fewer research resources than large colleges and universities, the new universities and smaller colleges have very high levels of ambition and are willing to fight for research resources.

The 1990s' research bills

I am not going to go into the two government bills on research presented in the 1990s in any great detail here. However, I would like to mention some predominant features of these bills, in order to identify movements that may help explain the reactions and counter-reactions in the development of research policy in Sweden.

Unckel's research bill

In February 1993, Per Unckel, the conservative government's Minister for Education presented the bill "Research for knowledge and progress"[84]. At the time, the government's research policy aimed to *prepare the ground for science to reach the forefront of knowledge.* The overriding goal for the new research policy, as it was expressed in the preparatory committees' special research strategy, was *to help create long-term conditions that nurture a competitive Swedish knowledge community and thereby promote both breadth and international expertise in Swedish research.*

The government's first priority was goal-oriented research projects in strategic areas. This prioritisation was closely linked to a specific government bill[85] concerning proposals for research using "Employee Monetary Funds", which formed the foundation for the Swedish government's decision to set up a number of research foundations, i.e. that several billion Swedish kronor were placed in

[83] Forskningspolitik [Research policy] SOU 198:28
[84] Prop. 1992/93:170
[85] Prop. 1992/93:171

foundations organised according to private law and independently of the state. The regulations in the articles of association for the foundations guaranteed that these resources would be used for research projects in strategic areas in order to improve the competitive ability of trade and industry and help resolve environmental problems, etc.

The second priority was to improve the exchange of knowledge between the scientific institutions and research and development departments in companies. This was founded on the fact that the government gave priority to research in areas of particular interest to Swedish companies. Chosen areas included biotechnology and (as it was called back then) microelectronics.

The bill drew attention to the great need for more trained researchers. The government presented a plan to double the number of doctorates by the year 2000 and called for investment in promising young researchers, plus efforts to increase the number of women researchers.

The bill expressed the government's desire to increase the possibilities for small and medium-sized colleges to do research, not least to maintain a high level of expertise outside the major cities. Special research funding was proposed for colleges that collaborated with universities and colleges with permanent research organisations. Research support was also proposed for small colleges that established joint research projects with industrial companies.

With Unckel's research bill, the government paved the way for more complex forms of knowledge production resembling what Gibbons et al. (1994) called mode 2 and strengthened the "contract" between academic research and trade and industry. At the same time, the bill maintained a traditional view of knowledge through unambiguous passages about the significance of basic research, cumulative knowledge growth, and the nature and purpose of research as seeking "the truth". The bill did not challenge people's understanding of knowledge processes by using terms such as interdisciplinarity. It was permeated by an overwhelmingly optimistic belief in the power of science.

Tham's research bill

In September 1996, the social-democratic government's Minister of Education, Carl Tham, presented the government bill "Research and Society"[86]. This bill underlined the ever-growing significance of research and new technology in the development of society and the importance of high-quality, relevant knowledge that can be better applied and meet society's needs. The social relevance of research is ascribed great importance in all research. The state bodies that fund research saw a change in their instructions with new requirements that the relevance of the research to be granted funding was to be given special importance.

This bill founded its understanding of research on problematisations, conscious risk ideology and nuanced reasoning about the significance of research in many different contexts. It was stated that possibilities and also problems were created through the major social and political changes that came about as a result of the internationalisation of economies, the labour market, science and culture. I would like to cite a passage (pp. 17, 18) that contrasts with the undisputed optimism in science in the previous research bill.

[86] Prop. 1996/97:5

> *Some of the changes we are seeing nowadays are direct consequences of new knowledges and technology. Research and its applications reshape every aspect of society. The development of information technology is revolutionising many people's work, living conditions and view of the world. It is leading to new design, new methods and systems, and developing new approaches, cultures and patterns of comprehension. […] Biotechnology […] puts complex ethical issues on the agenda. Through these and other results in science, our views of humankind, society and nature are called into question. Research and new technology thus have a powerful, and probably growing, ability to bring about change. The direction they take is decided partly by researchers' curiosity and the assessments of the research community. […] The major problems mentioned above cannot be resolved only, or even mainly, by new research and technology, but rather through social and political measures. Nevertheless, there is no doubt that new knowledge and technology will make important contributions. This applies nationally and internationally, to specifically Swedish issues and global problems. Therefore, the issue of how research resources are used is an important political question.*

The bill also contained a more in-depth discussion about knowledge production in society, pointing out the major ongoing changes regarding its forms and conditions. *The traditional, institutional and disciplinary frameworks are being complemented by new ones, marked by interdisciplinarity, heterogeneity, globalisation and integration of production and consumption of knowledge.* Where Unckel's research bill afforded opportunities for more complex, boundary-crossing knowledge production by focusing on collaboration between university research and trade and industry, Tham's proposition drew the consequences of this development and also gave it explicit descriptions, a broader context and instruments. This was done not least through the emphasis on interdisciplinarity, research ethics, gender research, support for small and medium-sized colleges, and collaboration with the regional labour market.

The general guidelines for research policy in the proposition, which I consider still apply are:

1. The focus of research must correspond to needs in society.
2. General research-policy decisions must be made by central government forces, while bodies with specialised knowledge within the affected areas make decisions concerning distribution of funds and activities.
3. Research financed by public funds must be subject to high quality requirements.
4. Research must be useful.
5. Colleges must increase their collaboration with the local community.
6. Research-ethical problems and the responsibilities of researchers in these issues must be afforded attention. 7 Equality within research communities must increase similar research with a gender perspective.
7. The links between education and research must be strengthened.
8. All universities and colleges will be allowed to administer their own research resources.

9. Swedish research shall contribute to international research and actively collaborate with research in other countries.
10. Sweden shall work to ensure that research funded by the EU provides broad support for development in Europe.

These guidelines indicate a change in terms of ideology and assessment compared with the previous proposition, which is partly determined by party politics. But even taking this into consideration, I still think that the guidelines together with the slightly more advanced analysis in this bill indicate a greater presence and clarity in terms of relevant and prevailing research and knowledge processes compared to the previous research bill. Nor can the differences between the two bills be explained merely by changes in developments over time. What is certain is that Tham's research policy was much more provocative to the research establishment. There are probably many reasons for this. I interpret the main challenge of this research policy to the system that performs research – demanding much more awareness about their own research activities and better argumentation for the relevance of activities – as providing ample opportunity for experienced provocation. The changes called for in the system that funded research were also met with resistance, not least because these organisations have long traditions and are reluctant to change.

The challenges are often linked to requirements about relating to the ever-changing realities and, as mentioned above, presence in the relevant and prevailing knowledge production processes. Mats Benner (2000) claimed that *In the same way as industry's noisy workshops were at the heart of the development of the industrial society, the "shop floors" in the universities – laboratories and experiments – are perhaps the current era's most important source of social and economic change. What happens in the lab shapes our future, how we will live, grow old, work and communicate. Information technology and gene technology are only the most recent and clearest examples of how technologies, originating from research, are revolutionising our living conditions.*

Attempts to balance the pendulum

The bills mentioned above and a number of official government reports[87] demonstrate how fashions in research policy swing back and forth like a pendulum. The negotiations related to research's social contract have been hard and complicated.

What type of contract can we see between research and politics, just after the 1990s? Perhaps we can glimpse some of the contents of the contract in the bill "Research for the future – a new organisation for research funding"[88], which the minister Thomas Östros presented three months into the year 2000. This bill came as a response to the turbulent situation in the research-funding system in the second half of the 1990s having serious repercussions throughout the entire research community. The bill entailed a compromise. The old, discipline-oriented knowledge production was given its

[87] Forskning och Pengar [Research and money] Swedish Government Official Report SOU 1996:29; Forskningspolitik [Research policy] Swedish Government Official Report SOU 198:28 (Research 2000); Vissa forskningsfrågor [Selected research questions] Government bill 1998/99:94; Att finansiera forskning och utveckling [Financing research and development] Ds 1999 (Report from the working group on how to structure the authorities that finance research), to name but a few.

[88] Prop. 1999/2000:81

clear, reproductive organisational form in the Swedish Research Council with its three specialised councils (defined by disciplines) and governed by a board with elected researchers in the majority. We could see a tendency in adjustment to more present knowledge and research processes in the merger of the research councils for natural science and engineering science. Sectorial research stayed on and was reorganised by topics into two research councils and one agency – the Research Council for Work and Social Issues, the Research Council for Environment, Agriculture Sciences and Spatial Planning and VINNOVA (The Swedish Governmental Agency for Innovation Systems).

The bill proposed continued negotiations between research and politics, between science and society be given special organisational form in the Research Forum. This body was to be charged with facilitating dialogue and collaboration between researchers, research funding bodies, the public and others who were directly or indirectly affected by research. Within the framework of the Research Forum's activities, it would be possible to openly discuss overriding research-policy issues that were not the concern of a single financing body. The bill gave examples of important questions such as ethical aspects of research, gender research, equal opportunities, research into sustainable social development, the conditions necessary for and opportunities afforded by interdisciplinarity, critical perspectives on science, etc. It was suggested the board to consist of representatives from the parties in parliament, all the research councils and other important authorities that finance research. Whether the negotiations that affected research's social contract were actually carried out within the Research Forum is not easy to see. It seems more likely that the real power arenas situated themselves elsewhere.

The view of knowledge production underlying the proposals concerning organisation was partially hinted at in the introductory texts, as well as in the government's judgement of and suggestions for the various councils. Terms used included the sudden developments in society and science and globalisation, research as an important growth factor, curiosity-based basic research, scientific quality, relevance, flexibility, joining forces, efficiency, collaboration, internationalisation, rejuvenation and renewal. Although it was stated it was no longer possible to draw sharp boundaries between basic research and applied research, between research and development work, between research initiated by researchers and research intended to resolve specific issues in society, it was still easy to revert to a linear view of the knowledge process. This was particularly apparent in the Swedish Research Council, which was given the sole task of promoting quality, *since free, curiosity-based research plays a central role as the springboard for other research* (page18). This approach was reiterated in the passage *Through the importance of free, basic research as a basis for other knowledge development, the Swedish Research Council will constitute the core of the new research organisation and will play a key role in developments in all sectors of society and policy areas* (page 20). In this case, the government chose "to keep science straight" and not abandon the modern project[89]. Minister of Education Thomas Östros reinforced this view of knowledge at the Swedish Council for Planning and Co-ordination of Research's Breakpoint Conference on 5 April 2000, when he claimed that *the higher (scientific) seminar is an excellent method for unveiling truths. Indeed, it would be a good thing if the whole of society worked like a higher seminar.*

However, this straightforward image of research does not apply to the other two research councils

[89] Liedman 1997

and the research and development authority, which are dominated by a more distributed knowledge production. If nothing else, the complexity of the applied field entails requirements for other research and knowledge processes, as is demonstrated in the text of the bill. The compromising attitude of the bill created opportunities and laid down limitations for knowledge production aimed at needs relevance, which goes far beyond the commercial needs in our globalised society governed by market demand.

Research policy and a college specialising in applied IT

Östros' research bill discussed IT research, stating that research related to information technology is being carried out within a range of different disciplines or in interdisciplinary collaboration across a broad field. In addition to different types of technical research, the area also covers research areas such as mathematics and physics as well as social science and the humanities (e.g. informatics, media and communication and aesthetics). The government deemed that the largest joint effort in the IT area was being done within the framework of the R&D program NUTEK (the Swedish Agency for Economic and Regional Growth) was responsible for. In the bill, the government pointed out that the efforts made by various different financing bodies together constituted a purpose-oriented Swedish investment in IT research. The government believed that the increased focus on user aspects and broader research outlines, as reported by the funding bodies, corresponded well to the government's general priorities.

The bill claimed that it was important to take advantage of the lead Sweden currently has regarding development and application of modern information technology in production processes and design of services. The government also believed it was important to persue R&D from a broader social perspective. The research-funding authority that was ascribed special responsibility for IT research became Swedish Governmental Agency for Innovation Systems (VINNOVA). One of the priority tasks was to coordinate, develop and focus on efforts within the IT area. Knowledge development in this context was primarily placed in an innovation perspective and linked to economic growth, ecologically sustainable development and social change.

We can see how Blekinge Institute of Technology (BTH) clearly related to these research-policy signals, partly through its specialisation in applied IT and partly through the Institute's interpretation of the "third task", which was formulated as "developing business and society". This interpretation was one of the cornerstones in the Institute's activities. The quality and development program for 2000 emphazised research and education to be useful to society illustrating the view that knowledge is not only generated within the ivory towers of academia and that learning is promoted by means of a reciprocal crossing of boundaries between theory and practice. The developments we are seeing in the area of IT in many cases have almost eliminated the gap between basic research, applied research and development of products and services.

The regional significance of BTH can also be seen in light of the discussions linking research and regional development policy. "Regional challenges and national R&D policy – on the way to a

national innovation system for public activities" was the topic of a conference[90] arranged by the Swedish Council for Planning and Co-ordination of Research (FRN) the same month as the bill on the re-organisation of research funding was submitted. The issue of innovations in government-funded research was high up on the agenda, where attention was drawn to hidden needs for innovation throughout the entire public sector linked to care services, schools, support for the elderly, infrastructure, etc. These activities are mostly performed locally and regionally, meaning the needs for research can be identified on these levels. The link to small and medium-sized university colleges is obvious. It is therefore important to ask whether in the future we will be able to speak of innovation policy for the public sector – often with a regional and local focus in its application – as a parallel to the innovation policy that is being developed so intensively for the regional goals within industrial policy? On a general level, we see tendencies towards the role of universities and colleges shifting from public service (the old, autonomous university structure) to public investment (the significance of the university colleges for regional development and employment[91]).

The backlash

As mentioned in the beginning of this chapter a number of research bills have been submitted since these of the 90s, but none of them has shown the kind of explicit link between research and politics as the one of 96/97 presented in this chapter. The criticism from the established universities seems to keep the understanding of autonomy and the linear model as the dominant discourse. A backlash occurred in the very end of the 90s for this research policy of trying to bring society into science and not only focus science into society. Carl Tham had to resign and the whole governmental research funding was reorganized with severe consequences for interdisciplinary research and gender research.

[90] Held at the Norra Latin City Conference Centre, Stockholm, on 30 March 2000. The conference was jointly arranged by the Swedish Council for Planning and Co-ordination of Research, the Dalarna Research Council, The Swedish Association of Local Authorities and the Federation of Swedish County Councils.

[91] Uhlin et al. (2000) provides an in-depth introduction to the complexity of regional innovation programmes and innovation system in the study "Modelling and facilitating prospective innovation systems".

Chapter 8

In this chapter I want to keep to the turbulent research political period in Sweden during the 90s and focus on feminist research politics. Since the 90s the system for research funding has changed. The discrete research councils for 'basic' research was in 2001 merged into a joint Swedish Research Council (VR) at same time as the Swedish Council for Planning and Coordination of Research (FRN) was closed down. I am presenting some situated experiences, which is mostly connected to the actor with explicit assignments for feminist research, namely FRN. In order to slightly reduce the collective forgetfulness concerning feminist research politics, I am going into some detail about a Swedish Government Official Report (SOU) of the 90s.

When Gender is on the Agenda[92]

Research political comments

Thanks to the efforts of a number of prime movers within the field, Swedish research politics in the 90s was putting gender on the agenda to an increasing degree. The discussions until then had focused on quantitative aspects of equality, such as how to increase the number of female researchers in technology and natural science, as well as the number of women in higher positions in the hierarchical structure of the universities, and how women can be given fair access to research funding (Wennerås 1995). However, when gender is on the agenda in a technoscientific context it would be better to start looking at the complicated and interrelated aspects of the making of technopolitics in the late modern research complex. In order to foster feminist research in this situation, frameworks for understanding characterized by transparency, context sensitivity and motivation to meet the relevant challenges in society need to be developed. We need to handle the twin aspects of research policy – science for policy and policy for science.

Feminist research has rarely been found among the issues addressed by research politics. However, we find in Sweden a number of professorships in feminist research in fields like history, sociology, economy, medicine and technology, which is intertwined with research political issues. These chairs have been suggested by the ministry of education and approved by the Parliament. In the Swedish context this has meant earmarked financial resources allocated to the universities, at which these chairs have been located.

Most of the academic research in Sweden is performed at the universities. In contrast to nearby countries very few autonomous research institutes exist in Sweden. The Parliament decides on allocation of basic (faculty) resources in the budget bill. These resources do not guarantee full

[92] This text is a modified version of a text first published in Contemporary Politics, vol. 5, nr 1, 1999.

salaries for research and higher education staff. External financing is necessary for research projects and programs, which constitute a comprehensive part of the economic base for PhD students and academic staff[93]. The outcome of the competition for external financing has a major impact on the ability of staff to keep their jobs. It also holds important and deep going structural dimensions of gender. In order to get the benefit of external financing it is necessary to apply for resources mainly from the Swedish research councils, which can be either 'basic' research councils or more applied research funding authorities.

One central agent in Swedish research politics is the research bill presented to Parliament about every three or four years. The first research bill appeared in 1981. In the research bill of 1993[94], strategic research was given a high priority, with the main focus of investments directed towards (in order of financial size) the fields of technology, natural science and medicine, followed by strategic environmental research and research in the cultural sciences. In this bill a proposal was put forward, and subsequently approved, for a new chair in feminist research within the field of technology, to be located at the Faculty of Technology, Luleå University of Technology.

Since 1991 and until 2001, the Swedish Council for Planning and Coordination of Research (FRN) was responsible for the support of feminist research and research concerning equal opportunities. The impact of this was a substantial increase in and concentration on research applications and project proposals in the field of feminist research submitted to the FRN - feminist research located both within the traditional academic disciplines and in the newer inter/transdisciplinary fields of study. The central role of FRN in the promotion of feminist research was an important phase in the creation of a financial base for this kind of research and its significant consequences. However, this central role played by the FRN contributed at the same time to a lack of responsibility shown by the discipline based research councils and other research funding authorities for the increasing interest in feminist research projects. There are of course exceptions that proved the rule, such as the Council for Research in the Humanities and Social Sciences, The Bank of Sweden Tercentenary Foundation and the Swedish Council for Working Life Research.

Feminist research politics

As pointed out above, FRN had a special commitment within the Swedish system for funding research to support and develop research politics on feminist research[95]. FRN was organized into programme committees, one of which handled project proposals for feminist research and equal opportunities research. Several calls were made for applications for general feminist and equality opportunities research projects. The committee did not give priority to any field in particular, the most obvious reason for this being the fact that very few other research funding authorities had shown any interest in supporting feminist research. However, one of the last calls from the FRN

[93] In 1993, 47 per cent of the research performed at the universities in Sweden was financed by external authorities other than the Parliament (basic resources) (SOU 1996:28 page 45). The percentage for external funding in 2014 was 55%.

[94] Research for Knowledge and Progress, Prop. 1992/93:170.

[95] After FRN was closed down, the commitment was transferred to an advisory committee on gender research under the board of the Swedish Research Council.

encouraged proposals in fields, where feminist research had not yet found a foothold, for instance in the natural sciences and technoscience.

The stream of feminist research projects included projects in a wide variety of areas and the number of projects increased every year. The budget allocation of the committee increased from SEK 3 million in 1991/92 to SEK 11 million 1995/96, due to changes in priorities within the total budget of FRN and by additional resources allocated by the Parliament. In the research bill to Parliament in 1993 it was emphasized that the committee should support activities in the fields of technology and natural science. The committee had, however, difficulties carrying out that exhortation. The large increase in number of project proposals was not followed up in research politics by a corresponding increase in resources. This meant the chances for having a proposal accepted continuously decreased and was less than half of the appropriation extent, compared with the other program committees of FRN. It should be mentioned that the relatively modest budget of FRN did not allow research projects to be fully financed, which was all too often the case in feminist research. The consequences of this situation were serious for the development of feminist research, especially for doctoral students and graduate researchers at the beginning of their academic career.

It is possible to identify the location of feminist research politics within FRN, which coincided with the research political role FRN was given and took. FRN, as an interdisciplinary and even transdisciplinary research council, was taken upon itself the mission to initiate and support new areas of research, which could be likened to tender plants in a greenhouse - plants that had special needs for growth. In due time these new research areas should be strong enough to be transplanted out of the safe environment of FRN and be able to compete on equal terms for resources in the common research funding system.

When it comes to feminist research, FRN found itself in a unique situation. It was not necessary for FRN to encourage interest in this new research field among scientists at the universities. The interest was already overwhelming. Instead, the task of FRN became to find methods for handling the large number of proposals, to deal with the evaluation process as a particularly pressing problem on the one hand, and a great need to expand the financial framework on the other. There were at least six identifiable strategies for increasing resources.

The first strategy was simply to ask for more money in the so-called detailed budget request of FRN, which was to be incorporated in the research bill and the budget bill to Parliament. This method was not too successful. The second strategy was to change priorities in the total budget of FRN in favour of feminist research. This was already been done (see above). The resources needed for feminist research alone, however, would take up most of the total budget of FRN. It would not be reasonable to give such heavy priority to feminist research, taking into account the other important programs of FRN. Other solutions had to be found. One of the more promising solutions appeared to be active integration of feminist research into all other program committees of FRN. I will come back to this strategy below.

A fourth strategy for increasing resources was to co-finance projects with other research councils. There was no reason why this form of research funding not becoming successful for feminist research. Comprehensive and conscious efforts from FRN would be required to develop smooth networks and, more importantly, to establish firmly the significance of feminist research among

other research councils. With respect to the universities, such efforts were not given priority in FRN with the result that co-financing of feminist research projects was not a feasible strategy. A fifth strategy would be for FRN to take seriously research political initiatives, also via the Ministry of Education, to influence other research councils and sector research authorities to assume the responsibility for financing feminist research within their particular fields of research. The government's research bill presented to Parliament in 1996 was surprisingly clear about this point, see below and in chapter 9.

A sixth way of financing feminist research would be to follow the suggestion of the official report "The wish to know, the wish to understand"[96] that is, to establish a new research council exclusively for feminist research. For several reasons I find this suggestion problematic as it would counteract the expansion and integration of feminist research[97]. The suggestion was not considered in the research bill 1996 and no separate feminist research council has yet been suggested by the government.

The establishment of evaluation processes within feminist research i.e. the selection of competent scientists, who can express an opinion about and judge project proposals, has proved to be difficult in a small country like Sweden. Within larger and more established research fields, for instance in technology, the existing network between Swedish scientists is considered to be too close, and the number of senior scientists too few, to recruit experts from Sweden alone. All applications must therefore be written in English in order to render possible judgments by researchers from outside the Nordic countries. Senior feminist researchers in Sweden are few and far between, especially within certain disciplines. Conflicts of interest, which must never be overlooked or underestimated and which will always exist, influence evaluation too strongly. Yet another phenomenon that further complicates the matter is the fact that feminist research is actually located both in the established disciplines and in the new inter/transdisciplinary fields of study. We will not get relevant judgments when, for instance, a sociologist evaluates feminist technoscience. This may be seen an obvious point, but it is not in the field of feminist research. Project applications related to feminist research need to be written in English to give us access to fresh and relevant evaluations by scientists outside Sweden and the Nordic countries. This problem could be solved, if feminist research is more firmly integrated into the different research councils, and if alternative criteria for the framework for evaluation are created (Gulbrandsen 1995c).

Technopolitical questions in feminist research

In the discussion above I have tried to steer myself away from the quantitative goals of equal opportunities issues, and towards identifying prerequisites for involvement of feminist research in the technoscientific matters at hand, and further to the present questions of research politics as a part of technopolitical movements. I would like to dwell a little upon the processes evolved within FRN, mostly because of the central role it played in research politics concerning feminist research. If there was any single place where you might find signs of shift in feminist research politics, it would

[96] SOU 1995:110, Viljan att veta viljan att förstå - kön, makt och den kvinnovetenskapliga utmaningen i högre utbildning (The wish to know the wish to understand - gender, power and women's research challenges in postgraduate education).

[97] For a further discussion see below.

have been within FRN. Accordingly, it was within FRN that we could identify new technopolitical tendencies by looking at the choices and changes in program committees and the priorities given to activities within these committees.

In one of the last detailed budget request[98], which was henceforth to be included in the research bill every third year, it was interesting to note that information technology gained a stronger position, in addition to the, from a research political view, interesting field of Science Studies[99]. At the same time discussions about the location and aim/role of feminist research were taken place. In the FRN's budget request it was suggested that the committee for feminist research and equal opportunities research should stay within FRN's framework, but change its name to the committee for feminist research. Another idea discussed was that feminist research, wherever it is possible, should be integrated into the other program committees within the FRN. The Committee of Technology and Society was in the process of being merged with the Committee of Research on Library and Information Science. Within this amalgamated committee, information technology was given greater priority. The program suggested by the new committee contained an explicit commitment to the integration of feminist research:

> *By increasing the number of actors in the development of technology and in the production of reality, that this development involves, prerequisites are created to overcome the obstacles of techno-optimistic or techno-pessimistic attitudes. In this context integrated gender perspectives are important.*[100]

According to my interpretation of this program, it constituted a breakthrough in the technopolitical question of feminist research. The theoretical and methodical competence of feminist research could here be practised and developed in a technical context, at the same time as the transformative and evolving capacities of feminist research would be placed inside the technoscientific field and accordingly be given opportunities for involvement in dynamic processes of knowledge production. The program of the committee was turning the focus from what Sandra Harding (1986) calls the women question in science to the science question in feminism.

A noteworthy research political event occurred within feminist research in the fulfilment of FRN's commission from the government to make a proposal for academic appointments in the field[101]. This happened during the spring of 1996. Having collected suggestions from all the universities in Sweden, in an attempt to solve problems of organizing the analysis work, in which both the committee of feminist research and equal opportunities research and the general secretary of FRN were involved, and after a thorough discussion of the challenges involved with certain members of the board of FRN[102], the final proposal was delivered to the government to be incorporated into the research bill.

[98] FAF for Swedish Council for Planning and Coordination of Research 1997 – 1999.

[99] In the FAF it is called *Research about research.*

[100] As it appeared in the text of the call for application 1997.

[101] After proposal from government in Prop. 1994/95:164 (Equality between women and men in the field of education) page 28 ff and after its discussion in the education committee of Parliament, report 1994/95:UbU18, page 26 ff, FRN was invited to suggest fields for professor chairs or other research appointments with gender research focus. FRN was also instructed to consult the other research councils.

[102] Presented in FRN-nytt (FRN news) nr 2 1996.

FRN's suggestion was to create one new professorship and to provide resources for one research assistant and one doctorate student in each of the fields of literature, sociology, medicine (people's health science), human-machine interaction, history of technology and anthropology. However no specific geographic location was suggested. The outcome of the research bill was the same number of chairs and appointments but in slightly different fields to those suggested, namely literature, sociology, medicine (people's health science), human-machine interaction, information technology and the didactics of physics.

Judging from the processes, which occur when feminist research is awarded resources, however modest, to expand, such investments evoked strong reactions, not only in the established academic community, but also and perhaps even stronger reactions among feminist researchers. Complex chains of events started when different interests were given a more or less free rein. The fact that at the time feminist research was the focus of attention for high status positions in the research complex, upset the gender neutral norm of the scientist's identity and the myth of the apolitical content of research processes (compared to other ways of understanding such as its mythic, organic, technical, political, textual content etc. (Haraway 1991)). At the same time it raised questions about the academic career system and how problematic that can be for feminist researchers. How to balance the interest of the own individual academic career and the transformation goal of feminist research? It is easy to experience a contradiction in this balance.

In the light of involvement in technopolitics, the proposal for appointments of new chairs in information technology and human-machine interaction could mean a possibility of intervention for the field of feminist research. The potential for the intervention in technopolitics was dependent upon where the chair was located - either in traditional fields of consequence studies or integrated into transformation processes in a technoscientific contexts

The fact that two of the six suggested and later approved research fields were related to technology indicated the influential role of technology in directing and shaping society and its productions of reality with far-reaching consequences.

Official report as feminist research politics

The former Minister of Equality and deputy Prime Minister, Mona Sahlin, set up an official investigation with the dual aim of finding measures for promotion of feminist research and ways to achieve a more equal representation of women and men at all levels in the research complex. The investigation was presented in the Swedish Government Official Report SOU 1995:110, called *The Wish to Know, the Wish to Understand - Gender, Power and the Women Research*[103] *Challenge in Postgraduate Education.* This official report was submitted for consideration by the parties concerned, it was debated at length in the media, and, together with the conclusions drawn as a result of its considerations, it was taken into account in the research bill in case. The criticism of the official report, both from feminist researchers and male researchers in the established academic system, needs a more detailed presentation and analysis than given here. I will concentrate on the parts concerning technology.

[103] in Swedish 'kvinnovetenskaplig', yet another term for what I have called feminist research.

In the report the technology field was commented upon in terms of statistics on resources allocated to women and female staff at universities and by different authorities. The discussion centred primarily around the representation of women. Apart from the comments made by the investigators, technology was treated on its own in my contributing text "The technoscience challenges in feminism". A variety of different voices from female emeritus professors, female students and from some male professors can be heard in the report.

On the basis of the material gathered and from the proposals put forward in the report, the conclusion drawn shows feminist research was made almost invisible within the field of technology[104].

It is obvious that the technopolitical interest in the proposals of the investigation was minimal. Perhaps we should not be surprised, considering the aims and direction characteristic of current feminist research in Sweden and the phases this research has been involved in. One reason for this is the dominant position social sciences have in feminist research in Sweden and elsewhere, by understandable and good reasons. However this dominance provides only minor potential for technopolitical changes and transformations, which in turn have repercussions for the production of technical knowledge and problem solving. Another reason is that feminist research, to a great extent and indeed legitimately, is involved in "mapping" projects, which have not proved to yield the transformation potential we hoped for (or have we hoped?!). This focus draws attention away from the work of problematizing the foundations of technoscience, which is a prerequisite for the involvement of feminist research in technopolitics in relevant, interesting and transformative ways. I am quite aware of the fact that the feminist research I want to see developed demands sensitivity within the research complex and that is difficult to motivate. It demands great courage from the researcher, who sticks his/her neck out. I believe in and value highly strong inter- and transdisciplinary connections in research praxis. This cannot be overemphasized in efforts to bring about the changes discussed.

In the investigation, as well as in Swedish feminist research politics a double strategy is proposed. Feminist research is still a bait not easily swallowed, leading to the need for both an autonomous and an integrated position. The investigation moved the centre of gravity in the direction of the autonomous position, in its proposal for the establishment of a centralized feminist research authority and a research council exclusively for feminist research. The impact on feminist technoscience is easy to imagine - the inevitable engagement in the technopolitical issues and the technoscience question would be made extremely complicated, if not impossible. Moreover, the argument for demanding responsibility from the actors within the research funding system disappears. The various fields of feminist research in the humanities, social science, natural science, technology etc. should not have to compete with each other within a research council of their own, but should compete and demand their legitimate position from the financial authority to which each individual project belongs. If we do not do it this way, we will find ourselves quarrelling about scraps while the guys are playing around with the billions. Besides, we would then make it difficult to have influence beyond the confines of our own project, that is to make gender irrelevant as an epistemological factor[105].

[104] SOU 1995:110, pp. 173.

[105] For a detailed discussion about deconstruction projects of feminist research itself, see Saarinen (1989).

A Research bill to parliament supporting feminist research

The most feminist friendly research bill to Parliament[106] so far was presented on 18 September 1996. Interesting differences can be noted compared to the former bill, which was dominated by the establishment of the research foundations. The former bill began with detailed reflections on the role of culture sciences (the humanities) in our society, followed by an overwhelming focus on technology, trade and industry, directed by the so-called "strategic research politics". The politics of feminist research were almost entirely reduced to quantitative questions of equality - of the "more women in" kind. There was no problematization of the dominant norms in the production of knowledge except perhaps for the creation of the new professorship in gender and technology.

So what happened in the bill of 1996? I interpret it as a breakthrough of sorts. For the first time, we now had a research political document that consequently made a distinction between feminist research[107] and issues of equal opportunities. One of the greatest achievements in the bill with regard to feminist research politics can be found in the statement:

> *It is the view of the government that it is of significant importance that gender research is integrated into established research disciplines and that the ordinary research financing authorities allocate resources to feminist research.*[108]

These demands are followed up in the bill in the section dealing with the different sectors of the research complex.

The introductory parts of the bill also make quite interesting reading. We find here, in my opinion, a more relevant identification of the role and limitations of research activities in our society, also in the global context of environmental and survival crises. The political role of science is acknowledged in statements such as: *How research resources are utilised is thus an important political question*, *The focus of research must fulfil the needs in society…all areas of society*. These explicit declarations do not rule out the occurrence, every now and again in the bill, of a naive and oversimplified view of research as a truth-seeking activity performed by enthusiastic scientists doing 'basic' research with minimal awareness of the complex context dependency of knowledge production.

It is in section 3.7 of the bill, which concerns equal opportunities and feminist research, that we find an explicit discussion about our understanding of knowledge, which in my opinion ought to influence all other areas of issues, ministries, research councils etc. - namely:

> *The person who defines what constitute a scientific problem has an influence on the results of the research and consequently the world view science creates and the kind of technology developed.*[109]

[106] Research and society, Prop. 1996/97:5.

[107] The concept used in the present bill is now gender research compared to women research used in the former bill. Feminist research is still too strong and charged a concept to use in a research bill in Sweden.

[108] Prop. 1996/97:5, pp. 55.

[109] Ibid. pp. 54.

> *Technology, trade and industry dominate this bill, for obvious reasons. As mentioned above the demands from the government concerning the integration of feminist research are followed up in consideration of different research sectors. For example, in the section on research into information technology (3.11.7) the government suggests "resources be allocated to a professor chair in information technology with gender perspective. This chair ought to contribute new aspects of IT development in society.*[110]

I want to highlight one strategically important proposal in the bill in case, which had the potential to lead to a breakthrough in feminist research politics, especially in technoscience. The government proposed a so-called united action group[111] among the existing research councils[112]. The instructions for the united action group focused three main issues - interdisciplinary research, feminist research and equal opportunities questions. The accompanying explanatory text in the bill states: *Besides promoting interdisciplinary research the united action group ought to support an increasing awareness of gender perspectives in research and control and coordinate equal opportunity efforts*[113]. A careful, ambitious and resolute handling of these opportunities would have potentials to create a basis for opening up all research councils for feminist research - a true research political challenge.

As mentioned above, the government proposed six chairs in feminist research and provided the additional resources in the bill. The impact of this increased allocation for feminist research was substantial, but by no means unproblematic. Three of the chairs were potentially in the field of technoscience and natural science (information technology, the didactic of physics, human machine interaction).

The research bill to Parliament was connected to a budget Bill. In the latter, the statement concerning support for feminist research was repeated in even more explicit terms:

> *Feminist research ought to be integrated into the ordinary research and in the research financing authorities, e.g. the research councils ought to allocate resources also to feminist research. Every research authority is obliged to participate in executing the measures and meeting the stated goals within its field of responsibility*[114].

Frames of evaluation

When gender is on the agenda, it becomes ever more crucial to discuss, deconstruct and reconstruct frameworks and processes of evaluation. The forceful movers and decisions made in a technopolitical context are influenced by evaluations that some feminist researchers regard very critically[115]. When

[110] Ibid. pp. 101.

[111] In Swedish Samverkansgruppen

[112] This is an alternative organisation to the proposed 'board of research councils' suggested by the official report on research financing, the results of which were presented in spring 1996.

[113] Prop. 1996/97:5, pp. 207.

[114] Budget Bill to Parliament for the year 1997, Prop. 1996/1997:1.

[115] At the same time I am well aware of some traditions within critique in Europe that, unfortunately, still are to be realized, see Gulbrandsen (1995).

technopolitics is located in a context of research politics, the frameworks of evaluation do not become less important or complex. In feminist research there is a potential for promoting transparency in the decision-making stages of the evaluation process.

Among the first things to stress is the political content of technoscience[116]. I am not referring to the consequences and political implications of technology, but the political content of the whole research process. When I transpose this consideration to the humanities, I run the risk of forcing open doors. If I, by contrast, bring up this discussion in a technical and natural scientific context, I commit a crime against the still dominant belief in neutrality of knowledge. The deep involvement of research activities in a political context is supposed to be kept hidden in order to uphold the status of research. The legitimacy of science is strongly connected to maintaining the myth of the neutrality of science and its apolitical content. The side effects of nurturing transparency in evaluation processes cannot be overestimated since the complexity of the processes is significant and the processes involved cannot possibly be viewed as obvious, even to a slight degree. The effects will shake the very foundations of our view of knowledge and raise the understanding of ourselves as profoundly mixed up agents in technopolitics, research politics and research. I can never locate myself innocently outside these processes.

Elisabeth Gulbrandsen (1995) states:

> *The reality producing / instrumental aspect of science and research demands devolvement of other forms of reflections; new forms for creating legitimacy, that are specific, concrete and detailed. More complex and integrated understandings of knowledge processes are needed in order to be able to give such localized and situated reflections.*

The evaluation system in the scientific establishment and its functions has not been the object of any detailed and continued investigation. In the established forum where the discussion is taking place, it is the formal rather than the informal aspect of scientific quality control that is in question. One important contributions to the discussion can be found in the international project about production of knowledge, supported by the FRN. Some of the results are presented in the book *The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies*. Its authors (Gibbons et al. 1994) write:

> *...scientific and technological knowledge production systems depend heavily and inherently on quality control. So long as science was a relatively simple, internal market of well-known, although novel products (for example scientists), quality control could depend on and be exercised primarily by members of the scientific elite itself on a largely informal basis. The process began with the education and selection of students, and was controlled subsequently through recruitment into the scientific community and to its elites by the mechanisms of peer review.*

[116] In science studies research has long since been recognized as a social praxis and process together with the view that modern science and technology have a political life (Lundstøl (1977), Rose & Rose (1969), Rose & Rose (1980)). During the 70s there was a catchphrase that society is in science as much as science is in society.

> *When the market expanded and became dependent on external, usually state funding, this informal peer review process was not replaced but rather supplemented by more bureaucratic forms of quality control exercised through committees, commissions and various other procedures. The claim of scientific excellence was maintained as the primary and overriding criterion for judging the knowledge produced and hence the knowledge producer. This chain therefore became an important mechanism for protecting the autonomy of the science system in the face of demands from the state and/or industry...in practice the difficulty of deciding priorities on the basis of a clear distinction between internal and external criteria remained. It is now generally admitted that internal criterion of scientific excellence per se is a necessary but not a sufficient selection criterion for establishing research priorities. Other criteria now influence the funding system. These require, both in themselves and in combination with other selection criteria, new procedures for evaluation.*

Hopes and expectations

The possibilities for feminist research open up in the Swedish research political system in the middle of the 90s created a great deal of hope and expectation. We know the processes needed to be started in order to transform the possibilities, the formulated words on paper, into available and located resources, are highly complex, not straight forward and demand a lot of work and problematization.

We find ourselves in a rather peculiar situation of parallel processes. We are dealing with learning processes at the same time as we are trying to carry out research integration. On the one hand we must find out and thoroughly learn about relevant integration strategies. Valuable knowledge and experiences could be brought from interdisciplinary research, where obstacles similar to those facing feminist research exist. On the other hand, coincidental to learning processes of how to do it, we have to *realize/effect* the integration into the financial system for research. At what point will the expectations and concrete results converge - both in the short run and in a longer-term perspective? How can our expectations and hopes be turned into resources for the ongoing transformatory work?

Chapter 9

As mentioned in chapter 8 a special window was opened for feminist research policy at national level during the years 1997 until 2000. The Swedish government created the conditions for explicit activities concerning the important issue of integrating feminist research within Swedish research funding authorities. In this chapter, I will shortly present some experiences from the work of the Committee for Cooperation[117] of eight Swedish research councils commissioned by the Swedish parliament. The specific assignments of the Committee included amplification, support and coordination of the activities among the councils, when it came to interdisciplinary research, feminist research and gender equity. In this presentation I will focus exclusively on the feminist research mission.

Integrating Processes in a Research Political Opportunity

The Swedish Research Bill was, as mentioned in chapter 8, for the time period exceptionally favourable for feminist research, as well as for interdisciplinary research. The 1996-1997 Research Bill and the corresponding Budget Bill of '97 and '98 were very clear on the importance of integrating feminist research perspectives into the disciplines and to give feminist research its regular place within the research funding system. The citations below show some content of the opened window. As stated in the Research Bill (1996/97:5, p.55) *It is the view of the Government that it is of significant importance to integrate feminist research into established research disciplines and for the ordinary research financing authorities to allocate resources to feminist research.* This was followed up in the Budget Bill (1996/97:1, p.147) declaring, *Feminist research ought to be integrated into the ordinary research and in the research financing authorities, that is the Research Councils ought to allocate resources also to feminist research. Every research authority is obliged to participate in executing the measures and in meeting the stated goals within its field of responsibility.*

Committee for cooperation of eight research councils

Knowledge about relevant and effective strategies for integration of feminist research into research councils was lacking. It was therefore an important mission for the Cooperation Committee to initiate integration processes and simultaneously develop integrative competences. The Committee for Cooperation consisted of the Presidents or the Vice-Presidents and the Scientific Secretaries-General of the following eight research councils;

[117] In the Swedish the name is Samverkansgruppen.

- the Swedish Council for Planning and Coordination of Research (FRN)
- the Council for Research in Humanities and Social Sciences (HSFR)
- the Medical Research Council (MFR)
- the Natural Science Research Council (NFR)
- the Council for Engineering Sciences (TFR)
- the Council for Social Research (SFR)
- the Swedish National Space Board (SNSB) *the Council for Forestry and Agriculture Research (SJFR)

The government appointed an external President for the Cooperation Committee, a professor in feminist researcher. I was appointed, which gave me a favourable understanding of the process from within.

In order to avoid any confusion here, I remind that the situation concerning the Swedish research funding system was changed after the period of the presented initiative. A new authority structure was launched in the beginning of 2001.

The assignment of the Cooperation Committee was utterly clear about separating feminist research and gender equity activities – a separation which was an important prerequisite for the work as feminist research and gender equity, however important, can not be considered as the same thing. Feminist research means development of scientific qualifications within different research areas. Gender equity means equal representation of and obligations and rights for women and men in the internal and external activities of the councils. Although the Cooperation Committee worked both with initiatives concerning feminist research integration and gender equity, I am here focusing the feminist research integration. One of the most important missions of the Cooperation Committee was to initiate integration processes and simultaneously develop integrative competences.

Expert group for integration of feminist research

Less than one year after the start of the Cooperation Committee, an Expert Group for integration of feminist research within the eight councils was launched. The aim of the work in the Expert Group was to foster the development of priority structures and decision structures in order to facilitate the evaluation and support of feminist research within the eight research councils of the Cooperation Committee. The core issues worked upon were the following:

- Identification of various understandings of feminist research and shifting developments of feminist research within the different disciplines the eight councils represented.
- Frameworks and processes of evaluation.
- Alternative research processes.
- The impact of the theoretical and methodological development of feminist research in the mother disciplines i.e. transformations of the mother disciplines.

The members of the Expert Group included representatives from the eight research councils as well as resource persons from three Nordic countries - Sweden, Norway and Denmark. The work proceeded with working meetings in Stockholm, with seminars in Norway and Denmark and finally with a Nordic conference in Stockholm late in September 2000. The result of the work of the Expert Group is presented in the report "The Relevance of Feminist research". This report can be seen as a kind of manifestation of the status of feminist research and feminist research policy in Sweden and in some Nordic countries in the late 90s and beginning 2000. The report was prohibited to be officially published although all the eight councils acknowledged authorship. I interpret this situation as a sign of felt provocation within the established research councils.[118]

Some conclusions

The conclusions below may seem self-evident for some. But we have to keep in mind the Committee and Expert Group were working with research councils starting to spell the word "feminist research". This did not prevent e.g. the Swedish National Space Board starting to signify feminist research.

The Expert Group concluded its work with the following conclusions and recommendations.

> It is important to confirm feminist research as a field of scientific qualification. This is not obvious in the presented context, as we easily slip into discussions of gender equity. Although gender equity is essential, we must also put on the agenda that feminist research is constituted by scientific competence.
>
> Feminist research is developing rapidly, nationally as well as internationally.
>
> Feminist research is generating theory and benefit in a variety of contexts.
>
> Feminist research has various focus and theoretical frameworks within different disciplines. Identification of feminist research within the fields represented by the eight research councils has started and is manifested in various ways. Examples are given in the report accordingly to the different disciplines.
>
> In order to integrate feminist research, there is a need for explicit research priorities. The experience confirmed the significance of the Research Bill to be very explicit in making priorities towards feminist research. The point needed to be stressed is the importance of these kinds of research policy signals for transformative work in bodies like research funding authorities.
>
> Feminist research integration is a challenge as such, a challenge to the hegemonic knowledge system.

[118] The report can be found as a pdf at http://www2.bth.se/tks/teknovet.nsf/(WebFiles)/5D3697EA83FFF4E2C1256F960037F87F/$FILE/Genusforskningens%20Relevans%20

> A double strategy is needed. Both an autonomous body in the research funding system and a concrete and explicit work of integration into the different existing councils are needed.
>
> The conditions for integration are long-term efforts, competence to integrate feminist research and coordination among the research funding authorities.

The Expert group summarized the needs for integration processes, when it came to feminist research. First of all, a dialogue between researchers with adequate competences and the council at issue was seen to be necessary in order to jointly identify research and its relevance. Quite a lot of work has to be invested in this dialogue. To go into a long-term dialogue with the staff in the councils was considered a prerequisite in order to identify the relevance of feminist research in the specific field of the council's responsibility.

Secondly, an explicit and anchored policy of feminist research integration within the research funding authority was identified highly needed, which brings us back to the importance of policy signals. Finally, a developed and useful qualification of evaluation was recognized as essential. This might seem self-evident, but experiences showed that was (and still is) not the case. The Expert Group explicitly highlighted the importance of having feminist research applications evaluated by feminist research experts in the specific scientific fields.

It was encouraging and fruitful to work in the Expert Group together with colleagues from Denmark and Norway. The exchange of experiences between research councils and other research funding authorities at Nordic as well as at European and international level was recognized as important in order to strengthen the work of integration and transformation.

Aftermath

The research political signals supporting integration of feminist research weakened drastically after the Tham era in the 90s. The institutional strength of the Swedish Secretariat for Gender Research[119], established as a result of the research bill of Carl Tham, has been important in order to keep up the feminist research political work. The Advisory Committee of Gender Research within the Swedish Research Council was struggling during many years and closed 2013. We still see few if any signs of integration of feminist research, when it comes to technoscience. Some integration initiatives have occurred within Sida SAREC and VINNOVA of the councils mentioned so far.

[119] www.genus.gu.se

Chapter 10

This chapter is a piece of work written 2010 mainly by my colleague Elisabeth Gulbrandsen with myself as a co-writer. The positions Elisabeth and I are taken are rooted in our experiences and mutual interests of needed transformative processes in contexts of academia, research policy and distributed knowledge production. I am most grateful to Elisabeth for letting me include this text in the book.

Scientific excellence has become the catchword for research politics, manifesting itself in the establishment of centres of excellence all over Europe as well as in the European Research Council. What is the meaning of this phenomenon? What will we find when trying to open up the black box of "scientific excellence"? The need to question evaluation processes seems intrusive, when we realize the increasing demands on knowledge production to be societally robust, not the least within the energy and environmental sector. How do we move towards a situation where scientific 'excellence' is automatically taken to include reflection and wider engagement concerning societal dimensions?

This chapter amalgamate a number of interrelated issues supporting the aim of this book.

Re-thinking Excellence; getting smart between the no longer and the not yet - comments on the convergence of knowledge and politics[120]

Introduction

The article "Authority in Transformation"[121] Elisabeth and I produced in the middle of the 90s, carries a message that has become more urgent with the passing of time. The quote from Sandra Harding's edited volume The 'Racial' Economy of Science reminds us that

> *...the declining authority of the West to determine how the rest of the world shall live requires a rethinking of the past, present, and future of Western sciences and their technologies no less than other important Western institutions and practices.* (Harding, 1993)

In a comment that we at the time "censured" into a footnote, we contended an understanding implying that we 'in here' have developed something valuable that we want to give to you 'out

[120] This chapter is a slightly revised text from Gulbrandsen & Trojer (2010).

[121] See chapter 2.

there', to be fairly widespread among Nordic feminist research. At a Nordic conference on 'Women, Development and Environment' in Oslo (autumn 1990) the Indian feminist / activist / researcher Vandana Shiva responded to our wanting to export our knowledge to Indian rural women by asking back "Who appointed you God?" As we find that it still is the scent of 'technologies of hubris' and not 'technologies of humility' – as figured by Sheila Jasanoff (2003) – that make us mark something as excellent research, we find it appropriate to keep writing the same article. Here we copy and paste the 2nd paragraph from "Authority in Transformation".

> *We argue that it is high time we make a shift. A shift that may seem simple but, as our own 'trying transformations' tell us; it is certainly not easy. Time is ripe for us, as partakers in the modern research complexes, to develop a readiness to think and feel ourselves as part of the problem, and learn how to use our implicatedness as a resource for transformatory projects. This shift represents our headline challenge. In this article we aim to expand on this challenge by spelling out some of the motivations for and implications of the shift, as well as pointing to conditions for carrying it through.*

We are still struggling with shift and with the learning. Being involved in more horizontal partnerships for learning and development is still quite challenging for expert systems in general, and perhaps especially so for academia, which have to shed its cloak of assumed neutrality and objectivity and create for itself a new role as a societal actor. This challenge is partly a consequence of research's growing impact and "success". Research is increasingly involved in every aspect of life. There can be no doubt that research plays a crucial role in the development of industry and commerce, it affects our decision-making processes, it colours our culture and steers the development of society. However, research and technology not only have an integrating effect on the development of society, research and technology are also always already integrated in the development of society in general. Or to put it another way, society also influences the processes of developing research and technology. Focusing on "society in science" will thus be at least as important as "science in(to) society"[122].

Co-evolutionary approaches

At this day and age – following a mounting environmental and poverty crises – there is a lot more unease with presenting research as the solution than in the mid-1990s. The weft of science increases in everything that surrounds us and it is at the same time possible to ask: What is progress these days? And how to measure it?[123] Increasingly open systems for knowledge production require a focus on the direct reality-producing effects of research – its "context of implication" (Nowotny et al. 2001). It is these features of the development that made Ulrich Beck query whether representative democracy is collapsing through development of the modern research complex as a separate policy area: *Politics breaks out in a new and different way, beyond the reach of formal responsibilities*

[122] "Science in society" became a catch word for science-society activities of EC during FP7. However, we saw how the focus was broadening to include struggles coming to grips also with "society in science" e.g in the expert-reports by Felt (2007) and Markus (2009).

[123] Reference to e.g. OECD's Global Project on Measuring the Progress of Societies.

and hierarchies. So we are looking for politics in the wrong place, with the wrong concepts, on the wrong floors, on the wrong pages of the daily newspapers (Beck, 1996, p. 24). We want to position our ambitions to promote more complex and integrated understandings of the relationship between research and society, in this grey area that Nowotny et al. (2001) ascribe to a dedifferentiation of the societal spheres of modernity.

The boundaries between politics and research are not straightforward and clear in a society that depends on research and knowledge. Nowadays it is even claimed that research and society are co-produced or co-evolve (see chapter 11), which is a long way from the simple, linear understanding of this relationship that has dominated research policy hitherto. Research is no longer merely a means to realise goals in other policy sectors. Research is becoming a policy sector in its own right. It is in the fields of technoscience (information and communication technology, bio- and gene technology and material technology) that scientists are most clearly pushing the boundaries between science and society, research and politics, thereby illuminating the obsolescence of a linear understanding (Gulbrandsen 2004).

'Innovation system' was one of the first concepts put forward as an interactive alternative to the linear model. Strategic research, post-normal science, triple helix, mode 2 and agora are other examples. The term innovation system is in widespread use in the Nordic countries. Finland is usually held up as the paradigmatic case because of its "founding" of the concept 'national innovation system' (NIS). Reijo Miettinen's analysis of how the NIS have developed in Finland can also be called paradigmatic because of his focus on the role of the NIS as a mobilising metaphor (Miettinen 2002). Miettinen talks about a double development in that it has become a scientific term and a political term. He introduces and develops *...an epistemology of transdiscursive terms that are simultaneously and interactively used both by scientific communities and in policymaking* (p.17). We believe that this is a perspective that can provide our tranformatory efforts with better tools to process changes in the relationship between research and society or science and politics, to produce more substantial, complex and integrated understandings and images of this relationship. By exploring other figurations like mode 2, the agora, post-normal science and technoscience as transdiscursive terms, we might be able to improve our understanding of the convergence between research questions and policy questions.

Miettinen discusses the extent to which Nordic social democracy and its political culture predestines political decision-makers and researchers alike to apply technocratic and pseudoscientific interpretations of the concept of NIS. However, it does not have to be so. Miettinen argues for a more modest way of relating by emphasising reflexivity, learning processes and contextual knowledge production. This is an echo of Haraway's situated knowledges (1988) and Jasanoff's technologies of humility (2003), rather than seeking mastery and control, we should focus on collaboration with ambitions of developing modulations in the diminishing gap between variation and selection or between promotion and control/regulation (Rip, 2002a). This corresponds well with discussions in policy studies concerning how a "governance by design" mode of working needs to be supplemented by a "governance through dynamics" approach[124].

[124]For an introduction to such discussions see Voß, J.-P. (2007): Designs on governance. Development of policy instruments and dynamics in governance.

The regime of collective experimentation

Even if the call for such co-evolutionary approach to science, technology and innovation (STI) is often heard, it seems hard to realise in practice and as culture. The so-called "regime of collective experimentation" suggested in an EC-report from an expert group on science and governance (Felt, 2007) is an articulation of this challenge. How to identify potentials for, how to design instruments for, how to promote, manage and evaluate productive interactions between "science and society" or between science, technology and the market? The report collects examples featuring the recent shift from the idea of centralized organization of innovation to explicit recognition of the importance of distributed and more diverse innovation. Referring to John Dewey's conception of policy as collective experimentation, the authors of the report contend that: *... the experimentation is now at the technological level as well*(p. 26). This move is inspired by experiments with "open innovation" in the business sector, and connects to the range of suggestive figures from the history of science policy such as mandated science, strategic science, triple helix, mode 2, post-normal science, agora. Still, it seems hard for science as well as for policy organisations to see themselves as involved in governance and steering issues, as societal actors in more horizontal partnerships, as key players amongst other key players. How come?

Figurations associating co-production of science and society indicate that such intimate interaction between science and society can further more societally robust science and technology. We must strive to open up a "reflective conversation with the situation" as Donald Schön phrased it in his influential work *The Reflective Practicioner: How Professionals Think in Action* (1983). This argument may still be felt to be provocating in some corners of research. How far into research will the arena for co-production extend? And what will the interaction be concerned with? Quality, relevance or both? To develop a role as co-player seems to be dependent on a mode of humility and acknowledgement of limits in singular positionalities, that can be hard to find. (Jasanoff, 2003, Felt, 2007) It might even be felt to be "contraintuitive" for researchers to move away from a "mastery and control" mode in order to ask for help and to open up for input from and collaboration with others.

Citizen scientists

Helga Nowotny, the central figure in European research policy and the former head of the European Research Advisory Board (EURAB), has for some time been calling for a greater degree of reciprocity in the relationship between research and society, arguing that this partnership presupposes more transparency concerning the processes involved in research and technology. Nowotny argues that it is the research system that need to be opened up, and she believes it is particularly important to be able to communicate "uncertainties, contradictions and contingencies" – everything that cannot be assured as "scientifically" proven and which therefore turns the spotlight on the idea of science / research / technology as based on neutral and to a certain extent "objective" knowledge processes. "A new kind of more mature partnership" needs to be developed, Nowotny claims, and this can only be achieved if the processes whereby research and technology are developed are opened up.

> *Science can no longer expect unconditional support on the part of society for whatever it wants to do, nor unconditional acceptance of its authority. Society will have to become*

> *more involved in understanding better how research actually functions and why it is important.* (Nowotny 2005c)

The same tendency is also evident in the United Kingdom, one of the leading countries in Europe in terms of development of the dialogue between research and society. Here, focus is increasingly on the process of developing research and technology. This shift is described as "upstream", and *Demos* positions the challenges thus in *The Public Value of Science* (Wilsdon, Wynne & Stilgoe 2005):

> *Those who see upstream engagement as a means of providing earlier and better predictions of risks and impacts are missing the point. It is not a matter of asking people, with whatever limited information they have at their disposal, to say what they think the effects of ill-defined innovations might be. Rather, it is about moving away from models of prediction and control, which are in any case likely to be flummoxed by the unpredictability of innovation, towards a richer public discussion about the visions, ends and purposes of science. The aim is to broaden the kinds of social influence that shape science and technology, and hold them to account.* (p. 34)

"Upstream engagement" refers primarily to the reflexivity of the research and technology systems, according to Brian Wynne. The requirements that knowledge must be reflexive and societally robust will only continue to grow in the years to come.[125] The conditions necessary to create a constructive dialogue with society seem to be rooted in the increased ability of the research system to open up and admit the limits of its knowledge. This is necessary in order for research to be able to invite collaboration with other social institutions. The same demand to be able to open up and acknowledge one's limits also applies to interdisciplinary work. One of the main challenges facing efforts to nurture interaction between research and society relates to inviting other parties to participate in dialogue in ways that make it possible and interesting for them to be involved and engaged. This requires what a report from the EC (Markus, 2009) calls the development of "further skills" by researchers, as they must be able to explicate their premises, conditions of validity, uncertainties, areas of ignorance, values and conditions of applicability to certain contexts. Because "Involving publics …, can be more productive if not only the knowledge at the object level is presented and discussed, but also the related metaknowledge."(p 14-15) Developing the dialogue with society thus requires major changes in expert systems in general and the research system in particular. One of the challenges lies in "bringing out the citizen in the researcher". Wynne (in the preface to Weldon, 2004) points out that this kind of understanding is just hatching:

> *The only recently recognised challenges of two-way understanding between science and its publics, replacing one way understanding of science, are in their very earliest days. This is emphatically a long haul, of nurturing not merely policy shifts, but profound cultural change in such science fields, their policy and technological uses, and the*

[125] There is increasing pressure (as articulated by OECD, EC as well as the president of US) on science and technology to address the grand and sometimes global challenges of our times – the 2009 Lund Declaration is just one example.

> *assumption underpinning them… .The bottom line issue in the new climate of "public engagement" is not just seeking earnestly for 'public inputs' – preferences, values or knowledge. It is being encouraged, by public dialogues and questions among other things, to question the validity of our own scientific-institutional taken-for-granted assumptions and routines.* (p. I)

If research has an impact on society and interacts with other research in ways that are not linear, it becomes necessary to address the legitimacy and responsibilities of research on a broader basis than merely through reference to the fact that public research grants are used and distributed by institutions and allocation mechanisms that follow strict internal quality requirements and professional norms. Helga Nowotny et al.(2001) stress that the dialogue with society must necessarily be an ongoing process:

> *That the authority of science in the future will have to be established in an ongoing process that needs to be worked out again and again in each concrete situation is the meaning of the somewhat aphoristic title of this final chapter of the book, that re-thinking science is not science re-thought.* (p 249)

Challenging research quality and excellence

Interactive policy models entail changes in the concept of quality. Contributing to productive collaboration and co-production between science and society, becomes an important mark of quality:

> *Recent discussions of Mode-2 science (Gibbons et al. 1994; Nowotny et al. 2001) has pointed out that ways of producing technoscientific knowledge already extend well beyond the classical 'independent' mode of basic science. Stronger roles of applications contexts and imaginations in the very production of knowledge, transdisciplinarity, and socially as well as epistemically extended peer-review are but a few elements which indicate much broader social involvement in how knowledge is produced and validated. This co-production of science and society changes the very meaning of notions like objectivity and rationality.* (Felt, 2007, p. 77)

It no longer suffices only to identify thematic priorities or societal challenges "upfront". We must also explore how research processes can be developed as productive interactions between different actors, how to develop and how to evaluate them as societally robust processes (Voß et al, 2006). A more complex, dynamic and open understanding of the relations between science and society, asks for the development of new competencies and skills in the research system. The challenges are of an institutional as well as of an individual kind, and they seem to touch especially raw nerves, maybe because assessing the quality of research relates to heavy investments (institutionally as well as individually) in specific forms of rationality. Indicating that we may have some triple loop

learning[126] to do, can be provocative regarding our professional identities. At the same time, if we are *not* able to discuss and explore alternative figurations of quality, the recourse to traditional academic standards will be imminent.

One of the more promising attempts to meet these challenges is situated in the Netherlands, still being developed by a network involving several policy organisations[127]. Their approach is called Evaluating Research in Context (ERiC). The comprehensive method that they propose takes into account the fact that much current research is produced in a complex socio-economic context, in which demands are made by a variety of social actors. Moreover, research that addresses complex questions (for example aids, global warming, migration, renewable energy) is often multi-, inter- and/or transdisciplinary and is conducted in a context in which experts with different backgrounds, knowledge and expertise operate and different demands and interests have to be negotiated. This complexity requires a different approach to evaluation than traditional peer review that mainly emphasizes scientific excellence and relies on publications in high impact journals for its primary indicators. Since quality in the ERIC-approach is defined as a multidimensional concept which includes the expertise of stakeholders in different social domains, they elaborate on the concept of quality by looking at these different dimensions, distinguishing in each the modes of production and interaction of researchers and a variety of stakeholders. This is the how they present their approach to evaluation (Spaapen et al, 2007):

> *Evaluation is not the same as accounting and control; that is, the evaluation of output in terms of certain benchmarks and indicators. The method we propose aims to include a form of second order learning that also put the meaning of benchmarks and indicators that are used into question. It therefore stimulates not only first order but also second order learning processes by way of reflection, debate and ongoing iteration between goals and methods.* (p. 29)

It is a major challenge – in changing times – that the models deeply inscribed in the statistical practices underpinning our monitoring and governance activities, are so hard make explicit and to put into play. The ERIC-network underlines the importance of paying attention not only to the input in research (people, money apparatus), and its output (publication and other products), but also to the 'throughput'. By this they mean the processes to mediate with the environment, for example co-operation and strategic alliances. This implies discussions about the strategic positioning of a research program, thus giving deliberation about goals and public methods weight. Taken together, these principles form a program that combines some of the lessons of classical pragmatism (notably the anti-dualism) and new governance policy-techniques; especially the mechanism for co-ordination and co-operation, that share a focus on 'learning processes'.(Spaapen et al, 2007, p. 29) We include a "conclusion" that they arrive at 28 pages later:

[126] Triple loop learning entails inquiring how we know that we are doing the right things, while single loop learning entail asking ourselves whether we are doing "things right" (first order learning) and double loop (or second order learning) concerns whether we are doing "the right things".

[127] The network emerged out of a project from the Consultative Committee of Sector Councils for Research and Development (COS) concerning how to measure the social impact of research. Later The Royal Netherlands Academy of Arts and Sciences (KNAW), Netherlands Organisation for Scientific Research (NWO), Netherlands Association of Universities of Applied Sciences (HBO-Raad), and Quality Assurance Netherlands Universities (QANU) have participated in the project, and Hogeschool Utrecht, the Ministry of Education, Culture and Science (OCW) and Rathenau Institute have been involved as observers.

> *The above lead us to the conclusion that we are not looking for an instrument to evaluate a specific research group or a program, but a process of interaction. And we are not so much looking for indicators that can tell us how good or bad the 'quality' of the research is, but we are looking for indicators that can tell us whether the group succeeds in fulfilling its mission in a relevant context.* (p 57)

As hinted at, the emerging acknowledgement of "unintended consequences" was stressed as motivating transformatory action and experimentation in STI. Another way of approaching this may be through the discussion initiated by Sandra Harding in her introductory chapter to The *"Racial" Economy of Science; Toward a Democratic Future* (1993). Here Harding re-interprets 'scientific illiteracy" as pertaining not to "humanists or … the working classes", but to "many scientists, policymakers, and other highly educated citizens". She contends that: *… most scientist are not in a position to evaluate in a maximally objective way important parts of the evidence that they use in arriving at their results of research, nor is the educated public provided with the information and skills it needs to detect such a problem.* This happens because *…elite science educations rarely expose students to systematic analyses of the social origins, traditions, meanings, practices, institutions, technologies, uses, and consequences of the natural sciences that ensure the fully historical character of the results of scientific research* (p. 1). In her Reflections on Gender and Science book from 1985 Evelyn Keller comes close to a similar description of the challenges: *Yet, while our sensitivity to the influences of social and political forces certainly has grown, our understanding of their actual impact on the production of scientific theory has not* (p. 5). It was Keller, who some years later, contended that scientists had to supplement the assessment that "it works" with questioning "what it works at" as well as "how it could have worked differently" (Keller, 1992, pp. 74). Sandra Harding's diagnosis relates to natural science, but is echoed by Brian Wynne's concerning the social sciences in the Afterword to *Governing at the Nanoscale* from 2006:

> *The mode of social science presented here involves more than intellectual dimensions alone. It also involves learning new relationships and responsibilities, with 'the public', with the natural sciences and with policy. And it involves social sciences becoming actors in those worlds as well as commentators.*
>
> *However, this leaves a continuing issue unresolved. If we are to engage in these more politically immersed relationships, and leave behind our well-bounded peer cultures, how are we to ensure that the knowledge we generate can claim validity?* (p. 77)

If we want to move from "speaking truth to power to making sense together" as Robert Hoppe (1999) has suggested, it entails exploring how we can evaluate research and technology on the move – between the no longer and the not yet.

In "The Agora and the Role of Research Evaluation" (Frederiksen et al, 2003) the three authors from Copenhagen Business School, note that the evaluation of research is undergoing change and that they want to *… investigate how recent societal developments – epitomized by the concept of the agora – influence research evaluations.* The 'agora' here denotes co-evolutionary figuring of the relation between science and society. In summing up they contend that:

> *The trust in science has traditionally been and to a large degree continues to be based on institutions that are attached to the idea of an autonomous and disinterested science (universities and the peer review system). If science is to engage in the developing and changing relationships with society and face the financial interests and power games and at the same time retain the public's trust, demands for a radical change of perspective and implementation of new methods or procedures in relation to the evaluation of scientific knowledge are unavoidable.* (p. 166 – 1667)

The issue of stimulating and developing conflicting and contested perspectives, is also part of what Arie Rip (2003) find is important in realising socially robust science and technology through 4th generation research evaluation. It figures quite prominently in the section "Knowledge production and assessment" in the before mentioned *Reflexive Governance for Sustainable Development* (Voß et al, 2006), especially in the contributions by Katy Whitelegg and Marie Celine Loibl. They are more focused on the processes of knowledge production than on the assessment of it, but it can be argued on the basis of their texts, that production processes and assessment or evaluation, should be closely interlinked, reference also to the ERiC approach as well as to the weight placed on reflexivity or triple loop learning in the discussions we have referred to in this article. This is a point brought forward by Arie Rip in a report to EC, June 2002; "Challenges for Technology Foresight/Assessment and Governance":

> *The key point, however, is to move away from a focus on our limited knowledge of the nature and extent of impacts (which will remain full of uncertainties) to the process by which they come about, starting with the here and now. The question of technological innovation and its impacts is a complex and real-time challenge for the actors. Prospective technology analysis must therefore also be "real time", and formative (a term from evaluation studies, where real-time evaluation informs, and thus helps to form, subsequent reflection and action). Anticipating outcomes (including impacts of the technology on society) must be an ongoing concern, rather than ad hoc efforts to persuade a sponsor or regulator that the innovation journey can continue.* (Rip, 2002b, p. 52)

In contexts of scares resources the quality issues in STI get explicit and easy to understand in e.g. research linked to income generating activities and solutions encountering fundamental needs for people and society like energy, food, water and communication possibilities. The robustness can be recognized on the ground by the stakeholders and people involved. Excellence in this context corresponds to concrete relevance, results and sustainability. Excellence in a Nordic, academic context corresponds more likely to peer reviewed publications and later e.g. proofs of concept to be piloted[128].

[128]For an elaborated discussion see "Normative machineries at work" in chapter IV (Felt 2009).

Government and science as key players amongst other key players

Co-evolution in a non European context e.g. in an East African context make sense in a very explicit way where the mission of the national universities existing and the Governments coincide in the main objective of poverty reduction. When faculties of technology and engineering position themselves as relatively equal partners with entrepreneurs in society for development in crucial production sectors, we find examples on how the Governments, no matter if local, regional or national, see the relevance and join in co-evolution processes[129].

Another indication that co-evolutionary and networking models are gaining ground can be found in the changes pertaining to so-called ELSI-research (Ethical, Legal, Societal Implications of new and emerging technologies). In the second phase of ELSI-research - being developed in US, UK, Canada, the Netherlands and Norway – ELSI was challenged to integrate its activities into technoscience, not to function as a way of outsourcing such concerns from the technological development processes ”proper”. The Netherlands, UK as well as the Nordic countries, have put much effort into inviting ‘society’ to speak back to ‘science’, of experimenting with different types of stakeholder involvement in order to establish the much sought for two-way dialogues and the productive interactions between science and society. The re-thinking of stakeholder involvement that we see e.g. in EC and UK, point out how the infamous ‘deficit model’ is simultaneously laid to rest and resurrected in these experiment. And they point towards a lesson, namely there seems to be a continuing failure of scientific and policy institutions to place their own science-policy institutional culture into the frame of dialogue, as a possible contributory element that hinders a genuine two-way dialogue. As Brian Wynne puts it, we are ‘hitting the notes, but missing the music’ failing to acknowledge the deeper challenges of opening up our institutions and assumptions to critical debate. The reflexive capacity to acknowledge that one’s framing of a problem is positioned and partial, and thus open to challenge from other perspectives, needs to be enhanced as well as assessed as a vital marker of scientific excellence.

Re-thinking excellence

This chapter is aimed to bring out a number of discussion threads on how the claim for excellence in research has been emptied of its substance. It is not enough to claim excellence out of the already existing normative machineries at work in the academic world. The question is what kind of quality in academic knowledge production that is relevant in what context and for what purpose. Both researchers and policy makers have to create and enter a joint learning space with a learning mindset in order to be able to tackle this never ending question. If we have learned anything from our experiences in cooperation with colleagues in developing countries, it is that research and politics are deeply intertwined and constitute conditions for innovative processes. One excellent skill here is how to navigate in a more or less totalitarian political system AND at the same time keep the university as autonomous as possible through learning alliances in-between scientists and citizens, official and local experts.

[129] For further discussions see Part IV.

We are discussing transformation processes – that we realize and try to take part in - as processes of mode 2 and transdisciplinarity. Ulrike Felt is exploring the changing academic research environments in a European context and how researchers encounter, transform and oppose these changes. Felt is emphasizing the issue of creating and inhabiting what she calls epistemic living spaces (Felt 2009). We recognize these discussions as an important prerequisite for ourselves and other inhabitants in the academic world in order to feel *intellectually and socially 'at home'* (Felt 2009 p. 231) and for *becoming answerable for what we learn how to see* (Haraway 1991).

Part IV

Contexts of Implication

My academic focus and great interest in epistemological infrastructures have constantly being the bases for my practice driven work on research and development. I seem to have situated myself in contexts and activities not yet established and sometimes constituting untouched land. This concerns development of feminist research within faculties of technology, transformation of 'the culture of no culture' in development of a new university campus as well as mode 2 practices in low income countries[130] fostering emerging innovation systems. These contexts might seem disparate but there is a red thread holding them firmly together, which I hope to show also in the chapters followed in Part IV.

Although I have dealt with a number of implication issues in chapters above, Part IV will tell stories from implications contexts becoming in bright relief as we find ourselves in contexts of scarce resources and where issues of survival are realities. I here direct the focus to contexts in East Africa. Chapter 11 is trying to set the scene. Implication contexts of ICT[131] is presented and discussed in chapters 12 and 13 focusing Tanzania and in chapter 14 focusing Uganda. The same countries are highlighted in chapter 15, where the implication contexts are cluster initiatives and emerging innovation systems.

For the chapters following I am most grateful to my colleagues and friends in East Africa and Bolivia, to Sida and my colleagues at BTH and SICD[132]. I am constantly learning.

[130] I use the concept 'low income countries' synonymously with the more frequently used concept 'developing countries'. I prefer to use low income countries.

[131] Information and Communication Technology

[132] www.sicd.se

Chapter 11

How will the understandings and practices of the knowledge productions I am carrying out in this book look like in low income countries? For sure the context sensitivity is an absolute must. There is no time for the western linear model, where the resources in the universities, however scarce, have to be utilized not tomorrow but today. In this chapter I will give some aspects on why and how initiatives from universities for trying other models like mode 2 knowledge production, inclusive innovation and cluster development are relevant, important and have a proved success record.

When Society Speaks Back – the relevance issue

Voices of society

Universities are relatively neutral bodies / platforms in political contexts that can differ profoundly. Please note relatively. The universities have to manoeuvre strategically, though, in order to be durable. In low income countries with more or less stable political systems the university is a vital asset for social, cultural and economic sustainability and development. The universities in these countries face challenging demands to have their outcomes used in society for economic growth, challenging of more reasons than e.g. in Europe. This means that the 'voice of society' in science argues for use of the very limited public resources in ways benefitting the people as soon as possible, if not immediately. Society speaks back in demand for relevant knowledges for survival and better living conditions. This is a strong incentive for finding other ways than a dominant linear way of disseminating R&D results, which often takes too long time and is not always efficient or context relevant.

The increasingly acknowledged non linear knowledge production processes stress the importance for us to assess the unknown, unspecified, uncontrollable, irregular in both research and political spheres. What follows for all actors is to admit there is knowledge limits in research. Sheila Jasanoff is emphasizing the practice of 'technologies of humility' in favour of 'technologies of hubris' in the dialogue between science and society. Jasanoff (2003, p.225) addresses the driving force for society to speak back in stating that uncertainties and risks are *part of the modern human condition, woven into the very fabric of progress. The problem we urgently face is how to live democratically and at peace with the knowledge that our societies are inevitably 'at risk'.*

Society and university initiatives

Technical Transfer

Technical transfer is still a dominant concept and practice within the western hemisphere universities. It is a concept of a linear paradigm - knowledges and technologies are produced at universities and research institutions, transferred with or without IPRs[133] to society with political approval if legislations or the political agenda require, and finally reaching the end user. The linear paradigm seems to prevail at least as long as the traditional, disciplinary (mode 1) university as well as certain economic-political actors dominates. Some of the impacts are frequently weak relevance to society needs, lack of efficiency, low level of trust within society actors, increased gap between different groups of society, weak capacity for evolving innovations and innovation systems.

In Sweden the technical transfer paradigm has been characterized by week context sensitivity and the faith in universal solutions. Technical transfer, in the linear mode, from a Swedish situation to contexts of low income countries in e.g. Sub Sahara regions includes few success stories. These experiences might be one of several reasons why the Swedish aid activities have moved from concrete practice to abstract policy during the last five decades (Kjellqvist 2013). A technical "transfer" in a non-linear mode and more of technical co-development between actors in high and low income countries call for approaches of "polycentric, interactive and multiactor processes for knowledge production" (Jasanoff 2003) including technology production.

Society Speaks Back

In almost every nation there is a notion of economic and cultural importance, when it comes to the role of universities. Knowledge as the main product of universities creates wealth in societies and stability. Universities can be seen as threats in dictatorships and assets in others and still universities are one of the most stable institutions in societies regardless political situation. In western societies and elsewhere the one, who is paying the bill for universities, is the government, read tax payers. The voices of the latter is increasing in strength or as Nowotny et al already (2001) highlighted

> *In modern times, science has always 'spoken' to society; indeed science's penetration of society is close to being a defining characteristic of modernity. But society now 'speaks back' to society. This, in the simplest terms, is what is meant by contextualization.* (p. 50)

The twin notions of 'science speaking to society' and 'society speaking back to science' are obvious. 'Society' is requiring and required to take part not only in the input phase but in the whole process (which more likely is non-linear) up to the output and outcomes of results.

I have experienced on a municipal level in a Swedish context how society, represented by the local government, explicitly manifested the need in being involved or at least have an insight in the whole input-operation-output process. The need for this involvement comes from the budgetary process in local government to have local tax resources approved for the input of research funds

[133] Intellectual Property Rights

and infrastructure requests of the university. What the mayor and local government directors need are good arguments for the relevance of this 'investment' in order to convince the local parliament to vote in favour of it. For this argumentation to be successful, the mayor of Karlshamn clearly announced, "input is not enough".

Since tax payers via the government are paying universities, the primacy of identifying the problems to be solved by research and higher education can no longer primarily be in the hands of science only. The loud university voice of 'curiosity driven', free research is loosing listeners, more likely in contexts of scarce societal resources. The relevance issue is becoming crucial – research for whom and with what resource priorities.

Mode 2 always existing

Co-evolving processes are important where relevance and contexts of application and implication constitute the essential elements. The frame of understanding co-evolution includes the triple helix concept (Etzkowitz, Leydesdorff, 1997), which gives us some comprehension of the structure of the actors involved. The main actors are universities (knowledge institutions), industry (private sector) and government (on any level). But the triple helix concept does not contribute with the core answer to how the co-evolving / triple helix process is carried out. One answer to the 'how' question can be found in the research processes termed mode 2.

The former Swedish Council for Planning and Co-ordination of Research (FRN) initiated and financed a study that resulted in the publication *The new production of knowledge* (Gibbons et al., 1994), where the research process mode 2 was thoroughly described. Another publication advancing this discussion followed in *Re-Thinking Science – knowledge and the public in an age of uncertainty* (Nowotny et al. 2001). Characteristics of mode 2 includes eg context of application, trans-disciplinarity, much greater diversity of sites of knowledge production, highly reflexive, accountability, novel forms of quality control, socially robust knowledge, and context of implication. The strong and hostile reactions from the dominant university (mode 1) representatives showed that the mode 2 understandings were and are really touching the raw nerves of the main academic discourse. The representatives of mode 1 representatives are more focused on disciplinarity, internally driven taxonomy of disciplines, neutrality, objectivity, context of discovery, hegemony of theoretical or experimental science, and a sharp divide of basic and applied research. But as Gibbons explained, mode 2 knowledge productions have always existed and mode 1 is a very efficient specialization of knowledge production. This specialization finds its roots in the scientific revolution in the 1600s (Merchant, 1980).

The co-evolution is not only a hand in hand process between actors within and outside universities. It is an integrating process between mode 2 researchers, predominantly mode 1 researchers and partners in society. One example from the Katwe Salt Lake cluster in Uganda (see chapter 15) is given by the issue of salt crystallization. A research team at KTH (Royal Technical University, Stockholm) is working on salt crystallization processes at different international sites. In one of their projects they used Katwe Salt Lake in Uganda as a case. They didn't collaborate closely with the salt extractors at the lake. They took water samples from the lake and brought home for studies at their laboratories at KTH. Their main priority was the basic, disciplinary (mode 1) research on crystallization frequencies of the salt. The results of their research show the salt crystallizing in

sequences / fractions, where the sulphur containing fraction crystallize first followed by the chloride containing and last the carbonate containing fraction. There are not very distinct borders between the fractions, but as a first recrystallization this first refinement step to remove more of the sulphur containing salt is a great achievement compared to the existing local situation. In order to have a so called table salt for human consumption the sulphur needs to be removed, as the added iodine chemically bonds to sulphur and can thus not be absorbed by humans. A low tech method can be used to detect the sulphur fraction and when the crystallization is about to move over to the wanted chloride fraction. The researchers suggested that the differences could be tasted with the tounge. This example[134] shows how mode 1 research can be linked to a distributed knowledge production of high context relevance i.e. a mode 2 approach.

Research support, societal relevance and aid

Academic Research and Societal Relevance

Helga Nowotny (2001, 1994) emphasized that knowledge seems to be accepted or approved not on the grounds of claims of higher scientific authority but on grounds of negotiations. This comes from a desire of knowledge to be open and sensitive to many interfaces, where contemporary knowledges are created in heterogeneous contexts. In our professional and daily lives we have to make choices just to be forced to make still other choices, which are not only technical but refer to all uncertainties to be taken into account and be responsible for.

In East African countries like Tanzania and Uganda the missions of the national public universities are clear and explicit about their role in society. In Tanzania the University of Dar es Salaam, UDSM, states its mission in 2013 as being "the unrelenting pursuit of scholarly and strategic research, education, training and public service directed at attainment of equitable and sustainable socio-economic development of Tanzania and the rest of Africa."

The focus of the relevance issue is public service and equitable and sustainable socio-economic development. The needs of the public have thus a broader context than commercial markets only.

This became explicit to me when I participated in the international academic audit of UDSM, Tanzania in 2004. I learned the importance of capacity building for research and education and for the outreach to society and identified needs. The outreach facilities were technical transfer units at UDSM, substantial amount of consultancy and the innovation and cluster programs (ISCP-Tz) supported by Sida[135] and starting in 2004. The consultancy by UDSM research staffs refers to the fact that much of competence needed by firms and organizations was (is) gathered at UDSM. There are other reasons as well such as UDSM allowing some percentage of the work hours for consultancies to increase the very low salary given by the state in the context of scarce resources. The National Strategy for Growth and Reduction of Poverty, MKUKUTA[136], conducted a kind of base and frame for the audit mentioned as well as at present time for the outreach functions of UDSM. MKUKUTA

[134] The salt extraction example was presented at a study visit at KTH, Department of Chemical Engineering, 2013 08 28.

[135] Swedish International Development Cooperation Agency

[136] http://www.imf.org/external/pubs/ft/scr/2011/cr1117.pdf

forms part of Tanzania's efforts to deliver on its national Vision 2025[137] and is since 2005 focused on growth and reduction of poverty; improved quality of life and social well-being; and governance and accountability.

It is interesting to note that Economic Report on Africa 2013[138] states the following

> *Africa's industrialization is likely to take place in a changing globalized economy full of uncertainties. African governments should therefore work together to develop a united vision on how to influence the global economic agenda and, in so doing, shape the outcomes of globalization itself. The time has come for Africa to stop being a bystander to its own destiny.* (p 14).

This is argued when

> *Africa maintained well above global average growth in 2012, despite deceleration in the world economy.…West Africa recorded the highest growth followed by East, North, Central and Southern Africa.* (p 39)

In Uganda the Makerere University is formulating its mission 2013 as "to provide innovative teaching, learning, research and services responsive to National and Global needs". The overall aim of its research and innovation policy "is to reinforce vigorously the university's status as a major international university that sustains and adds value to the Ugandan culture, to the natural environment and to the economy and society of Uganda and the wider world. The university, therefore, shall put in place a research agenda with priorities that address national and global challenges."

Aid and Research

Sweden's Policy for Global Development (PGU) was approved by the parliament in 2003. The Swedish government reports to parliament on the PGU biennial. In 2007 the Swedish government (conservative at that time) presented a more specific policy for Africa[139], where it emphasized the importance

> *to support Africa's own research development, by among other things promoting initiatives aimed at creating fora for collaboration between research, industry and society. This type of network, which is largely lacking, is a prerequisite for African countries to develop research results, conquer new technologies and develop products and solutions.*

[137] http://www.tzonline.org/pdf/theTanzaniadevelopmentvision.pdf

[138] http://www.uneca.org/publications/economic-report-africa-2013

[139] Skr. 2007/08:67 *Sweden and Africa – a policy for common challenges and possibilities.*

Sida is in an international context one of few governmental aid agencies giving long term support to research capacity building in collaboration with low income countries. The mission of Sida is to reduce poverty in the world on behalf of the Swedish parliament and government. Sida contributes to implementing PGU.

During the years 2001 to 2006 I was a member of the Sida research board appointed by the Swedish government. The research unit at Sida at that time was SAREC[140] responsible among other issues for capacity building of universities in the collaborating countries. The participants of the board were researchers with mainly strict disciplinary backgrounds and came predominantly from old and well established universities in Sweden, some few from nearby countries, and all with extensive experiences of collaboration with low income countries. I felt odd in this board not because of less experience in low income countries but because I was (am) an explicit transdisciplinary, mode 2 researcher and also as I was the only person coming from a technical faculty. The work in the board and with linked committee obligations was a true learning experience not the least because of all very competent staff members at SAREC.

I volunteered to engage myself particularly in following more closely the SAREC support to the technical faculties in East Africa - Tanzania, Uganda and Mozambique. It was in this context I got involved in the support of SAREC to the programs of development of innovation systems and clusters (ISCP) starting in 2003[141]. When proposals for these programs was up for decisions at the board I expected a hard discussion and resistance from my board colleagues because of the inter-, and transdisciplinary character as well as the proposals' radical break with a traditional linear paradigm of use of research results. However, the decisions went smoothly to approval with very few discussions. My understanding of the reason is the well prepared, substantial and precise documents for decision formulated by specific, skilled and experienced SAREC staff members. The strategy was to take decisions step by step instead of a joint, big program, which was planned from the beginning. This strategy had both its pros and cons. On the positive side was that the concept of innovation, which was new in a Sida context at the actual time, could have time to find its format. The stepwise strategy also facilitated the possibility to handle all uncertainties in a program, which was new of its kind and started in processes not yet known in practice in East Africa. The negative side was lack of needed flexibility in waiting for new decisions, while the program processes accelerated. It later turned out that the reorganisation of Sida with the closing of SAREC and loss of skilled SAREC staff was a disaster for the ISCP. However, the fundaments for the program in East Africa and from 2008 also in Bolivia were in place and sustainable enough, while Sida funding was integrated with less resources in bilateral research agreements (for Uganda and Bolivia) and in specific arrangement with the Swedish embassy in Mocambique. Rwanda later came on board in the innovation supporting initiative at the university of Rwanda because of specific circumstances.

Dissolving the linear paradigm

As indicated above the linear model for diffusion and use of research results is in question and about to transform into other procedures in emerging collaborating universities or developmental

[140] Department for Research Cooperation

[141] For details see http://sicd.se/?page_id=2

universities (Arocena & Sutz 2011). A different university culture is needed for more immediate benefit to society especially in society contexts with limited resources. This brings us back to the issue of "a new kind of more mature partnership", that Helga Nowotny (2005c) was emphasizing and stating in "science can no longer expect unconditional support on the part of society for whatever it wants to do, nor unconditional acceptance of its authority".

It seems easier to dissolve the linear paradigm in low income countries, where the public good is a question of survival more than the commercial benefit of a few.

In order to move from the linear model of knowledge production and as well as of innovation development and evolution, it is not enough to link academic research with private sector and industry. It requires at least three key players, that is university, industry and government, which constitutes the triple helix model presented above. In order to come closer to innovation issues I want to use the general understanding of the Triple Helix model from Triple Helix Research Group[142].

> *The Triple Helix concept comprises three basic elements: (1) a more prominent role for the university in innovation, on a par with industry and government in a knowledge–based society; (2) a movement toward collaborative relationships among the three major institutional spheres, in which innovation policy is increasingly an outcome of interaction rather than a prescription from government; (3) in addition to fulfilling their traditional functions, each institutional sphere also "takes the role of the other" performing new roles as well as their traditional function. Institutions taking non-traditional roles are viewed as a major potential source of innovation in innovation.*

The Triple Helix model is a frame and a boundary object (Star & Griesemer 1989), on which involved actors can join and find out understandings and roles in always complex contexts and circumstances. That is a big step forward in the process of dissolving the linear paradigm. But it is not enough. As mentioned earlier, the Triple Helix model does not by itself means that we all know how to work together and develop the integrating process, which brings us to mode 2 again.

In the discussion concerning mode 2 and the role of future (and present I would say) universities Arie Rip (2002c) argues that

> *indigenous (and local) knowledge has become important, and creates a challenge to Western-science-as-we-know-it. Underlying world-views are now being articulated, and this raises the question about the world view embedded in Western science. Multi-culturalism is not the answer to this question, but is definitely the site to explore possible answers. The African Renaissance movement, and the official recognition in New Zealand of Maori approaches to knowledge production are two of such sites. Clearly, science in the 21st century will not be like science-as-we-know-it.*

One concrete way to test and practice the distributed knowledge production and inclusive innovation as indicated in mode 2 research is cluster development based in Triple Helix contexts.

[142] Triple Helix IX International Conference, "Silicon Valley: Global Model or Unique Anomaly?", 11-14 July 2011, Stanford University, Human Sciences and Technologies Advanced Research Institute (H-STAR), Triple Helix Research Group http://www.triplehelixconference.org/the-triple-helix-concept.html 2011.

Cluster and Innovation System

In the Sida supported cluster development in East Africa and Bolivia cluster initiatives are used. A Cluster Initiative may be initiated by government or academia or a private sector development agency. Innovation-driven actors from different sectors aim to support renewal and competitiveness industry, firms and farms. A decisive factor for the development of the Cluster Initiative (CI) is cluster facilitation supporting the decision making and collective action among the stakeholders in the CI. The Cluster Initiative is not the cluster itself. The core of the cluster is the firms, companies, often small and micro firms in East Africa clusters. The CI consists of all the companies and organizations that are linked together – in collaboration and competition – in value creation. The CI is the conscious attempt and activity to mobilize and organize all the actors and resources to make individual companies and firms in the cluster more innovative and competitive.

An integrating process is taking place in successful cluster initiatives. The roles of the actors get increasingly clearer and the integration of different support systems evolves. The integration also means an emerging innovation system including all different actors, on local, regional and/or national level. These parallel processes can be experienced in Uganda at local level (see chapter 14, 15) but also at national level. In the latter case the results of the innovation system and cluster program (ISCP-Uganda) motivated the Uganda President to support this cluster program in 5 years starting July 2010. The resource originates from the national government budget. This situation is relatively unique for university programs supported in addition by foreign aid. The resources were allocated by the Ministry of Trade, Industry and Cooperatives with a memorandum of understanding between Makerere University, where the cluster secretariat was placed, and the Ministry. A national steering committee for the cluster program includes representatives from the triple helix actors. The Uganda context however implicates a number of challenges such as weak or absent institutions, financial systems etc. In spite of that, the Uganda example constitutes condition for an emerging innovation system needed for a more sustainable situation of socio-economic development.

The experience presented above gives us an example of how 'society speaks back' in a constructive way. It is not until concrete and tangible results are demonstrated to the local and national government they become willing to invest. The cluster program with comparably small amount of support from Sida thus constitutes one successful activity giving relevance to the government and society.

Robust knowledge

Academic research within cluster collaboration is at danger, if it is not deeply anchored in the local context. The danger comes from the context of extremely scares resources and little space for risk taking, if any, within the cluster. The cluster members in East Africa are mostly poor people with family responsibilities.

If a resource, vital for the cluster firms, is found to be profitable, chances are that more powerful external actors see opportunities to exploit, buy land or property, introduce more high-tech methods or go into business in ways that do not benefit the local economy and the cluster members. Situations

are also such that, when the cluster firms become more profitable, the risk increases for external interests to manipulate the cluster members and take over. This can be observed both in Uganda and Tanzania.

Robust knowledge for socio-economic sustainability and development relies on context sensitivity. There are numerous examples of genuine context sensitivity and knowledge among participating researchers and students from East Africa and Bolivia in the cluster programs existing now more than 10 years. The learning processes born from context specific knowledges are vital for results people can rely on and build their futures upon.

Chapter 12

There is a story to be told about how ICT entered into Tanzania. The national university in Dar es Salaam (UDSM) was a key actor[143]. It is also a story about an emerging innovation system for ICT. The time window is the years just after the millennium shift. During these years an organisational change took place at UDSM. The faculties of technology and engineering merged into a College – CoET with specific benefits for the innovation processes. A university never stand still at least not when it comes to organisational structures. CoET later changed form into more than one college. In this chapter we keep to CoET as it existed the first decade of the second millennium.

ICT and ITS Emerging Innovation System in Tanzania[144]

Questions to be met

– How can postcolonial ICT (Information and Communication Technology) exceed the dominating discourse of western technological determinism?

– How can postcolonial ICT meet the needs of developing countries?

– How can the ICT development at universities become a driving force for societal progress in developing countries?

– How can innovation systems including the role of universities be understood and developed in postcolonial situations?

– How can potentials for a triple helix model be dealt with?

These are questions for comprehensions on how ICT can be involved in local and national innovation systems in developing countries. Special attention is paid to the role of the university as an important stakeholder in local and national development processes as well as to the prerequisites for postcolonial identities to make their mark on a nationally situated ICT development and implementation. The discussion addresses the emerging implosion of postcolonial situations and ICT development.

Academic ICTs and their applications in society and every day life force our attention towards the relation between dominating actors, of which the university is one. It stresses not only the development of innovation systems but a relevant knowledge about its prerequisites resulting in transformation challenges for the traditional universities. The model explored for these processes is the triple helix model stating that the three institutional spheres university, industry and government are increasingly working together and co-evolve[145].

[143] The story has some similarities to the story of Sweden and the role of the university, in this case the Royal technical university KTH.

[144] This chapter is a revised version of Trojer (2004) and parts of Rydhagen, Trojer (2004).

[145] Examples from regional contexts are given in (Uhlin, Johansen 2001, Henningsson, Trojer 2005)

ICT and the role of universities - a technopolitical and postcolonial challenge

When ICT development issues are situated in the context of knowledge- and technology co-development between low and high income countries, the need for understandings and praxis of postcolonial ICT emerge and the challenges for the academy and its technical faculties increase. *Relevance* seems to be the multiple stemmed core concept and the change of position from merely transfer to co-development is strongly in demand.

This chapter elaborates how ICT can be involved in local and national innovation systems in developing countries with special attention to the role of the university as one of several driving forces for local and national development.

We can realize ICT as one of the technological science fields most evidently provoking the borders between academic research and political sector (Gulbrandsen 2000) and experience how the 'negotiations' (Aas 1999, 2000a, 2000b) about the character of academic research take place in society. This is evident also in a European context.

The challenges involved in ICT development and the role of universities are commented by means processes appeared in a Tanzanian context. It is a translation of situated knowledges at a specific time, namely the experiences and understanding of Tanzanians engaged in national ICT working in Dar es Salaam in 2003, namely professionals at University of Dar es Salaam (UDSM), Civil Service Department of the President's Office, Tanzania Telecoms Co Ltd (TTCL) and Tanzania Commission for Science and Technology (COSTECH). The comments are also based on own experiences as well as material from Sida SAREC and from UDSM.

The national ICT policy of Tanzania

In March 2003, a policy proposal was approved by the Cabinet and since then, Tanzania has a national information and communications technologies policy[146]. The process for working out this policy started in the beginning of the year 2000 with an informal group sharing interests and visions of ICT to be successfully applied for Tanzania's development. This informal group became the so called eThinkTank. In April 2001 the Cabinet designated the Ministry of Communications and Transport as the national focal point for ICT. In September the same year a national ICT Task Force was formed as a multi stakeholder partnership to advise the Government on an ICT policy using the eThinkTank's inputs and Sida's funding. The ICT Task Force had 15 members and was headed by the Vice Chancellor of the University of Dar es Salaam (UDSM), professor Luhanga. The ICT policy process was open in order to have as many inputs as possible from persons with very different interests and perspectives. Drafts were circulated to the Government, members of parliament, private sector, academics and other stakeholders and even outside Tanzania. Drafts were also put on web pages for comments. The process incorporated regional and local political levels in Tanzania. In the stage of preparing the final draft a large meeting was held with 400 participants including persons from outside Tanzania like Sweden and Ethiopia.

[146] The document can be found at http://www.ist-africa.org/home/files/Tanzania_ICTPolicy.pdf

The University of Dar es Salaam played a key role in the ICT policy process. The ICT Task Force was, as just mentioned, chaired by the Vice Chancellor of UDSM not only because of his official position but also because of his expert knowledge and engagement. Two skilled persons from the university staff were brought into the secretariat in order to formulate and write the drafts. The draft was developed in a very broad and open anchoring process and thus moderating the preferential right of interpretation of the academy. This role of UDSM furthermore can be viewed as an advanced technopolitical "negotiation" between the university and the Government. We have to keep in mind that the knowledge experts of ICT in Tanzania were at that time mostly located at UDSM or trained at the same place as the only institution having a technical faculty in the country[147].

The national ICT policy gives a substantial understanding of the status of ICT in Tanzania as well as emphasizing 10 strategic areas for ICT and development and is a very well formulated document. One of the central statements concerns the needs for Tanzania to move from being mere consumers of technology to the processes of being designers and manufacturers of ICT[148], which will be commented below.

The ICT policy stopped at chapter 4. Longer texts in earlier drafts were addressing more of implementation strategies. It is important to note that from the very beginning the Task Force agreed not to locate the organ to deal with the implementation of the ICT policy within the Government. The Task Force also wanted it to have enough authority to coordinate and oversee ICT issues in the 10 focus areas in both the public and private sectors. Designing such an organization proved to be a daunting task. Hence the decision by Cabinet to shorter this chapter and defer it until later did not come as a surprise but reflected the thinking of the Chairman and that of the majority in the Task Force. The policy states the following in chapter 4 concerning the implementation issue.

> *Because of the multifaceted nature of ICT issues and the factors that impact on them, the implementation of this policy, and the consequent achievement of its goals and objectives will be the responsibility of the entire government at all levels and in all sectors, working in close partnership with the private sector and civil society. There is therefore a need for the active participation and involvement of all individuals and national institutions. There is also a need of a strong commitment on the part of the political leadership of all kinds and at all levels. In order to effectively coordinate and harmonize efforts and activities undertaken by many institutions in different locations, there is a need to put a mechanism in place which will ensure that the policy is updated from time to time and that implementation strategies and plans are drawn and carried out in the most efficient and effective manner. The final goal should be the deployment of ICT in all sectors of the economy and to all communities in Tanzania.*

[147] As far as hardware and software skills are concerned, skills for the training of professionals in both these skill areas were available only at UDSM. Training of hardware sub-professionals was done at the Dar es Salaam Institute of Technology and at several other institutions offering Cisco approved courses, for which the. University Computing Centre Limited (UCC Ltd) served as the Regional Academy for the local "Cisco Academics" spread all over Tanzania imparting skills in hardware and software. As far as acquiring skills in software applications is concerned, many institutions, both public and private, were active and they are regulated by the National Council for Technical Education (NACTE).

[148] See chapter 3.3.1 in the National ICT Policy document.

The role of the university

Background

The University of Dar es Salaam was born out of a decision taken on March 25th, 1970, by the East African Authority, to split the then University of East Africa into three independent universities for Kenya, Uganda and Tanzania. The University of Dar es Salaam consisted in 2005 of six faculties and CoET (College if Engineering and Technology) including three engineering faculties (see below), five institutes and two university colleges: Faculty of Aquatic Science and Technology, Faculty of Arts and Social Sciences, Faculty of Commerce and Management, Faculty of Education, Faculty of Law, Faculty of Science; Institute of Development Studies, Institute of Kiswahili Research, Institute of Marine Sciences, Institute of Resource Assessment, Institute of Mass Communication and Journalism; the University College of Lands and Architectural Studies (UCLAS) and the Muhimbili University College of Health Sciences (MUCHS). The University also operates a Library, University Computing Centre Ltd, Dar es Salaam University Press (DUP) Ltd and two centres; Centre for Continuing Education, Centre for Entreprenuership Development as well as concultancy activities within Economic Research Bureau and University Consultancy Bureau (UCB). Other centres were the African Virtual University Learning Centre (AVU-LC) offering degree, diploma and certificate courses in computer science using open and distance education platforms and the Technology Development Transfer Centre at CoET, the Instructional Technology Resources Unit (ITRU), which imparted skills to academic staff to enable then conduct online instruction. UCB handled consultancy at University level. There were other units at College, Faculty or Institute level e.g., the Bureau for Industrial Cooperation (BICO) and the Bureau for Education Research and Extension (BERE) all coordinated by UCB.

The context of the universities in post-colonial Africa must be considered with great care in order to understand the relations particularly between the University and the Government. Luhanga et al. (2003a) give an elucidative insight into the processes of transforming the colonial African universities to national universities. The situation was particularly precarious in a political situation characterized by single party states including Tanzania. The threat of increasing state repression to institutional autonomy became a reality for a number of universities. "State presidents became chancellors of public universities to ensure increased powers to curtail any opposition to their student enrolment expansion programmes or to handle any other politically motivated moves by African universities" (Luhanga et al. 2003a, p. 8). The appointment of the former Secretary General of the then ruling party TANU, as the first Vice Chancellor of the University of Dar es Salaam has been associated with the desire of the Party to entrench itself in university affairs in order to safeguard the interests of the peasants and workers of Tanzania (Luhanga et al. 2003b). This historical and political background implies a specific connotation of university autonomy. UDSM has been and is involved in a complex and delicate situation quite different from what is describing for universities in Europe (Nybom 2001). This Tanzanian context additionally contributes sharpening and multifaceted knowledge about the role of universities in societal development.

In the background presentation of the ICT cooperation between UDSM and Sida-SAREC the

following is stated[149]. "As part of the on going transformation program, the UDSM has initiated a number of reforms aimed at improving its main outputs (teaching, research and services to the society) through ICT. The improvement of ICT aims to suit the needs of the students and staff, the working environment and establish linkages with both industry and Government. The new ICT developments are also expected to contribute to income generation in order to complement Government and other funding sources to ensure sustainable academic programmes."

Relevance

The Vice Chancellor emphasized that within the larger transformation activities of the university the issue of *relevance* becomes central to the mission of teaching, research and service to the communities. As far as possible, a public university in a very poor country must aim to be able to be relevant to the developmental aspiration of the people. Addressing development concerns means that the University must have impact on whatever area.

The transformation should go deeper in the academic culture, the Vice Chancellor argued. Out of the 16 objectives in the strategic plan of UDSM, one concerned the change of the organisation culture within the University. *I must say it is not easy. If you want to bend a fish you bend it while it is still alive, before it is dry. If dry you crack it. We have come to learn that it is a bit difficult. We are still struggling with it.*[150]

At Tanzania Commission for Science and Technology (COSTECH), which is a Governmental body, certain reflections upon the role of the university can be found. A high level representative for COSTECH did not want technology to be an academic exercise. He thought the universities of Tanzania had not transformed themselves 100% to be more directed towards the user of society. The question of relevance seemed to be sensitive for COSTECH, which wanted to own that question. "We think that university should produce people who are relevant for us in the field, people who can challenge us in what we are doing, be catalytic in their activity, can conceptualize reality of things…. Many universities solve academic problems not practical problems." Examples of preferred projects for students were databases of the villagers, repacking local knowledge and multimedia tool on cd. The Tanzanian perspectives were stressed.

COSTECH used to be a research council with a lot of assistance from Sida SAREC. The balance between research for the sake of research and research for development was difficult to handle. Certain circumstances contributed to a change of mission for COSTECH to have a much broader mandate. COSTECH was seen more as an umbrella institution connecting and transferring knowledge, science and technology with and to society.

UDSM as a national resource for ICT infrastructure

The experience of approving ICT at the University started in 1993 with the establishment of a

[149] Retrieved 2004 at www.sida-sarec.udsm.ac.tz

[150] from interview 2003 09 12

university email system[151].

Transfer of technology needs a special organization, like marketing intelligence in private sector, but nobody thought about that at the University. The beginning of the 90s was the time of the Internet entrance. It was UDSM, which brought Internet to the Tanzania telephone company (TTCL) and not the other way around. In many countries the telephone company gives access to the Internet to the university[152]. Internet powered the head quarter of the telephone company. However, in this period there was a lack of knowledge about Internet. Both the university staff and management clearly saw the benefits of Internet. A VSAT link was installed at the main campus of UDSM. In order to provide internet services to the University campuses outside the main campus, a radio link at 2 MBps was installed as well. TTCL headquarters was connected to the University network via the radio link. Ten years later Tanzania had Internet backbone in every region of the country. The challenge for the university 2003 was to look out on how to transfer the technology to the industry. As a result of the that process and the role of the university, expert people from UDSM became managers at TTCL.

The role of the University in supporting access to Internet and digital interconnections did not stop with TTCL. The university tried to extend the Internet service to Government departments. The Government could at the time of the introduction not pay the telephone bill. When TTCL started disconnecting the Government, the university decided to take the eight ministries out of the telephone network for Internet access and connect them with the wireless line at UDSM. They had to find alternative solutions.

Gradually, the prices for Internet access came down and several ISPs[153] entered the scene. When the university started to raise money for the services there was no licence system. Some years later the system was in place and the university competed with the other ISPs. The impact of the initiative coming from the university was an enhancement of the motivation for the university staff to keep on with ICT development. This technology was appreciated as exciting and they were the only people who knew. A somewhat parallel process of integrating the then Faculty of Engineering (FoE) with the then Institute of Production Innovation (IPI) to form the Prospective College of Engineering and Technology (pCET) with three new engineering faculties, was probably boosted by the initiatives. In 2005 pCET got its formal status as College of Engineering and Technology (CoET). The university staff engaged was eager to see Tanzania on the map, as they knew how to build the systems. The Government as well as the University was trying to find the easiest way to implement the Government's own processes and demands, which were monitoring, evaluation and easy communication. UDSM was trying to provide that kind of solutions.

[151]The UDSM started e-mail services using a Low Earth Orbit Satellite (Health net) before starting the dial up services. Then as presented by Mutagahywa (2003 page 474) GreenNet routed the messages through London. Given the high cost of international calls, the UDSM hub called once a day to London to download and upload messages. The email messages were the printed out for the recipients, who paid about 0,10US$ for the service. The demand for the service grew rapidly. More modems were added to the system to service not only internal clients but people outside the University as well. This email service was provided by the Computing Centre.

[152]In Sweden, Internet was introduced in the 80s. Like in Tanzania, initiatives grew from a University, namely Royal Institute of Technology (KTH). The centre for Internet supply (KTHNOC) at KTH became the hub for development of the Swedish Internet. The net had its core at KTHNOC and was linked up to the Swedish universities under the name SUNET, Swedish University Computer Network (http://basun.sunet.se). The success of the Swedish Internet development depends on a high degree on personal and trustful relations with Internet pioneers in USA (Hamngren, Odhnoff 2003).

[153]Internet Service Providers, also known as Internet Access Providers. It is a company that provides infrastructure for access to the Internet or for interconnecting other ISP and content based or application based services on the Internet.

The technology transfer role of UDSM is explicitly defined. The University started the development by investing heavily in ICT at the University in terms of human resources, infrastructure and software. It was made possible by donor funding and own efforts. After less than 4 years of implementation, UDSM recognised the ICT development not to be sustainable. They had to find ways and mechanisms to bring in more resources than the Government and donor funding could provide. The ICT services included 24 hours network, with all the systems depending on it. The Computing Centre of UDSM started to use the extra capacity to tap private resources back to the university. The Computing Centre became a registered company owned by the University. This arrangement was also established as a result of critique from private companies, which thought the Centre was not paying taxes neither being legal. Because the Centre was a company the university could transfer all the technologies and expertise they had. They had some of the best people in network and hold the biggest network in the country – wireless, fibre, databases etc. An example of services provided by the Computing Centre was a network for the whole airport system in the country, a contract obtained in open competition. They were designing the system and others were constructing. The Centre was also conducting a project of developing a system for socio economic databases for the local authorities for the whole country. The same data was used by the regional administration and imported at ministry level.

It has been stressed (Mutagahywa 2003) that two factors were dominant for the development of ICT at UDSM. The first one was the existence of a University ICT policy and master plan widely accepted. The ICT policy was approved by UDSM in 1995 and implementations started in 1996. The second important factor was the championship of and support by the top management of UDSM.

CoET at UDSM

As CoET was a key actor in the emerging ICT sector in Tanzania and as contexts of my main concern is situated at faculties of technologies, I am going into some details when it comes to CoET.

The Faculty of Engineering was established in 1973. Its integration with the Institute of Production Innovation in 2001 resulted in the establishment of the Prospective College of Engineering and Technology – pCET, which received its formal status as College of Engineering and Technology (CoET) in 2005. The faculties within pCET were Civil Engineering and the Built Environment, Electrical and Computer Systems Engineering, Mechanical Engineering and Chemical Engineering. In September 2003, the number of undergraduate students was about 1350, while the number of postgraduate students was 171. At the same time there were 36 PhD students including 4 female. The aim was to have at least 10% of undergraduates continuing to postgraduate studies. The number of staff was 110, of whom almost 80% held a PhD degree. Consultancy work was favoured by the staff and was coordinated by the College's Bureau for Industrial Cooperation (BICO)[154] as an organ of CoET and thus part of UDSM.

The main motive for CoET was to fulfil one step of the university strategy of reducing a lot of duplication and pooling of the resources in order to become strong in the technology area. CoET can be seen as leading the process of gathering resources at UDSM.

The basic objectives of CoET were:

[154] PM Sida SAREC 2003 04 28 to the research board of SAREC.

- to supply the country with sufficient middle and high level engineering human-power as agents of development and change, thus contributing to the domestic development of infrastructure, industry and trade,
- to perform research in the interest of suitable exploitation and local processing of natural resources in Tanzania, ultimately leading to the innovation of technical products and production processes for the local industry, and
- to provide expert professional services in the form of consultancy to industry as well as public and private organisations and institutions.

The core issues for ICT implementation from the perspectives of CoET were

- technical staff, educate technicians
- reach the remote areas
- content, what do you do after technical infrastructure
- long term agenda for UDSM was to increase the output. In campus to get distant students and distant education also within the campus.

ICT literacy was very much in demand, which meant respective graduates from CoET were absorbed very fast by the industry after receiving their bachelor degree. The demand was expected to be even higher, when reaching also the rural areas. There was a big problem, the biggest headache for CoET, to keep good students for research and academic career in order to build the capacity needed at the faculties. Professors found themselves lucky to remain with those students who really want to stay at the university, about 1 of 10. The students concerned found jobs better paid than at the university. The motive to have a PhD in ICT was further decreased by the lack of interest from the private sector to appreciate staff with a PhD degree.

In January 2011 the College of information and communication technologies (CoICT) was a established. The activities at CoICT was until then part of CoET.

University Government relations

As indicated above, the relation between UDSM and Government showed some complications. The actual political situation in Tanzania with introduction of global market economy and multi party system was changing this relation. Not the least the national ICT policy process in Tanzania showed other kinds of links between the University and the Government, both on a knowledge sharing level and on a personal level as mentioned above. In addition, the Minister of Communication and Transport at the time was a professor from UDSM. You find professionals that in the same person hold competences as ICT experts trained at the university, as former employed experts at ministries and as managers in ICT related companies partly privatized. That person was in

her/himself an innovation system. In a country of scarce resources and with knowledge and technical skills concentrated in one institution - that is the University - this situation was not unique and held certain potentials.

Governmental support to higher education and research

Only undergraduate studies at universities in Tanzania were supported by the Government including allowance for transports, books etc. Postgraduate studies were managed by the university itself. There had been no fees for higher education. The system was at the time in a transformation stage. The Government decreased the number of grants as well as allowances, hoping individuals were willing take over. The conflicts, which arose, were somewhat met by introducing higher education on loan basis for students, who could not afford a fee and living expenses during studies. The university assisted the Government in drafting an umbrella bill for this purpose.

Tanzania had no national research funds. For development of research there was no money from the Government, which only sponsored undergraduate (bachelor) – on a decreasing level. The Committee of Vice Chancellors had put forward proposals to the Government in this matter. Sida SAREC firmly stated[155] that support would be continued only if the Government through relevant Ministries was willing to engage in a dialogue on the role of research and knowledge for Tanzanian development, and if this dialogue was reflected in strategic interventions from the Government. At CoET they were looking at the evolving research financing system in South Africa. An East Africa regional cooperation in research financing was though to come on a later stage.

The ICT infrastructure issue

From the Governmental side it was stressed that a lot had to be exploited. For instance, how to link up the very important institutions in the country like the major hospitals?

In 2001, a conference was held at UDSM concerning networks between the University and the Government itself and other training institutions as well as telecom companies. The question was, if the University took a leading role, would the others follow? There was a potential with an institutional arrangement linking to universities and other institutions and thus helping to develop their own capacity. At the same time, it was cheaper to run and develop from the old networks.

For ICT implementation processes in society, University computing centres were distributed to different places. Pilot centres for distant education, mostly short courses, were already in place for instance in Arusha, Mwanza and Dodoma.

University Industry relations

The engineering education and the results of university activities are vital for the Tanzanian industry. At the same time, it is important to learn about the needs of the industry, to have relevant feedback from the stakeholders and from the students. CoET at UDSM decided to work that out, regularly every 5 years, in order to find out whether they moved in the right direction or not and look at research and other activities for relevance. UDSM invited the Government and the industry for

[155] PM 2003 09 22 to research board of SAREC.

discussions. It meant a revised curriculum every 5 year. However, Tanzanian industry is young and there is a lack of response. The industry was often recognized to be unable to interact with the university. The situation was connected to the change from socialist to market economy system. In the private sector, few companies had been able to stabilize. *We need close cooperation. If we play a too dominant role they will run away from us. We have to calm down. When they are doing their own things, we should establish contact and accommodate. Then they will appreciate us. Though, it is rather uncomplicated with the industry compared to the Government.*[156]

The University is in different ways connected to innovative production at the industry. For SMEs it has a double effect with employment of graduates. Industry is recognized to be changing to more sophisticated activities and open for more interaction. Some researchers and faculties were directly assisting different industry sectors like mining, agriculture, fishing and manufacturing. UDSM had an Entrepreneurship Centre. As thoroughly presented by Mwamila, Katalambula (2004) and briefly commented by Diyamett (2004), CoET had two major outlets for technology development and innovation – Bureau for Industrial Cooperation (BICO)[157] and Technology Development and Transfer Centre (TDTC)[158]. BICO was focusing consultancy and services while TDTC focused technology development and transfer with the important role of technology brokerage.

When raising the questions about consuming and producing ICT in Tanzania, situated experiences from mixed perspectives were bringing alternative strategies. "In order to be active on the production side, the easiest way is to make ourselves credible as big consumers."[159] This strategy had somewhat started in the Government finding retail levels like the reduction of taxes on computer equipments. Bringing down the prices meant support the local second hand market. When the big manufactures got an order on for instance 50 000 computers, they would be sniffing around to find out how to improve computers design for the Tanzanian environment (dust proof, water proof). A disadvantage could be turned into an advantage. There was no lack of interest among manufacturers in this respect.

Another line concerned the problems in the education system. The students did not have the skills the market needed. One company person stated that you have to go finding the right skills in Kenya. If ICT and education were not driven by the demand side, there had to be a rethinking in the education system. The transformation of teacher training was crucial as well.

For the subject of science there was a major problem. It was neglected in secondary schools as the resources were (are) scarce. The Faculty of Science had started producing B.Sc. (Ed) graduates one of whose major subject was computer science. These were earmarked to be teachers of computer science in secondary schools.

Under the Secondary Education Development Plan (SEDP) the Government had already made a decision to convert two Teachers' Training Colleges into Constituent College of the University of Dar es Salaam.

[156] Interview at pCET 2003 09 15.

[157] Over 4 000 participants from the industry and other organizations including participants from all 25 regions in Tanzania had attended professional development courses aimed at enabling them to keep close with technical development. (Mwamila, Katalambula 2004 page 8)

[158] All technology development by the pCET staff, technology brokerage as well as the subsequent transfer to industry was coordinated by TDTC. (Mwamila, Katalambula 2004 page 11)

[159] Interview at Civil Service Department of the President's Office 2003 09 11.

Emerging ICT innovation systems

It is not self evident to use a concept like innovation system in a Tanzanian context, first of all because it is originally a western formulation and experience. Secondly because the situated relevance of the concept is still to be evolved as the ICT discourse is extremely western dominated with few cracks in favour of African situated interpretations and experiences.

As a starting point for discussions an understanding of ICT innovation system as a function or process of close cooperation between the Government (national or local), the University and private sector made some sense. The ICT Task Force was interpreted as unique concerning partnership. The three main stakeholders mentioned met in the Task Force and produced a joint policy supporting this kind of cooperative thinking. Persons active in the Task Force emphasized the need to educate the private sector to be patient. The impatience of private sector was a true challenge as the Government was experienced as a very slow moving machine. Initiatives from private sector were more likely to be reshaped by the ministry. Harmonizing the different interests not the least the ones of keeping status quo in order to defend old privileges is not easy. Adding the interests of the university makes the situation even more complicated.

The University was regarded if not as the major stakeholder in this system so at least, in the actual situation of a severe shortage of trained professionals, one of the most important. "The institutions of higher learning, such as universities, have a major role to play in generation of knowledge that enables smooth functioning of national technological capacity." This was a statement at an opening address by the Minister for Science, Technology and Higher Education, Hon. Dr Pius Y. Ng'wandu (MP) on the occasion of the Regional Conference on Innovation Systems and Innovative Clusters in Africa hosted by UDSM, at Bagamoyo[160].

A very practical example of an ICT innovation system in Tanzania is what happened at the Tanzanian Telecommunication Company Limited (TTCL). TTCL was a state-owned company. After privatization the Tanzanian state was still the major owner. Although the monopoly of TTCL was expected by TTCL to disappear within a year or two, it had a lead of operating the national network. The interests of the Government and of the appurtenant private sector were connected to the University in the following way at TTCL. TTCL was used for research and training as well as connectivity for the University. Some master students were funded by TTCL. The project work of the students constituted pilots implying mutual learning for the students and TTCL. They jointly captured important knowledge. The University and TTCL joined hands in being employers with a number of students working at TTCL. In addition TTCL paid a professor chair at UDSM. The need for mutual development was recognized and supported by having University research trained people as managers at TTCL.

A number of University professors considered the private sector to be very unfair. The sector did not want to invest in research for mutual development. The companies were only looking for graduates sponsored by someone else, leaving the whole burden to the Government. The professors gave example of one firm with an opposite attitude. The firm was a mobile phone operator having the

[160] 18th of February 2004

opinion that down the road the firm is sure to need graduates to take up some jobs. They were prepared but still planning to take over the support for these students for 2 years up to bachelor. Contacts between the company and students were established. This was a kind of new model the company wanted to keep secret in order to have a competition advantage compared to other companies wanting the same students.

Another alternative wished for was the private sector to team up with the University. Instead the sector cooperated with foreign consultants. The question about why they went for foreign consultants, when they had local consultants was raised. The private sector argued the income taxes should provide resources for education and research.

Many can agree with the professor at UDSM stating that Tanzania university heritage rest a lot of western world way of knowing things. The same is for the industry and the Government in particular. The changes in Tanzania were not yet stabilized. The Government was unable to comprehend things and cope with the open trends. Generally, the University and the engineering sector had a strong relationship with the Government from the beginning. The sector depended on the Government and appreciated the role of the Government recognising training of students as an input to the development of the country. It was considered important that the University was involved in the policy and the strategy development.

ICT implementation in a postcolonial situation

Acute issues for ICT implementation could be identified in the fact that there was no real owner at high political level. The Ministry of Communications and Transports was coordinating the efforts to find the appropriate owner, who could channel all the efforts. A Governmental voice said the issue was not whether you had a ministry as an owner or not. ICT is a matter for many ministries. What was needed was a matrix function for integration of ICT. People running the matrix should be innovative. Another issue was funding. Government as the largest employer should be the largest provider in order to reduce the uneven distribution of connections. Concerning ICT infrastructure one idea suggested was to utilize other sectors to build networks like combining with railways construction and maintenance work in order to avoid waste due to duplication.

The University performed a lot more in terms of infrastructure and hardware development. Very little priority was given to the content area like local content even in educational institutions. Situated development in these areas was suggested to be pushed by organisations like East Africa Community, Southern Africa Development Community (SADC) and the African Union. You might not have the critical mass in one country to address the issues. You can do it more efficiently on a regional level. Addressing context sensitive content development was considered to be a major regional issue.

When integrating ICT in development programs, low income countries like Tanzania are necessarily disadvantaged. The partnerships Tanzania goes into are not necessarily going to be in its favour. One of the persons interviewed stressed that “it is very unfortunate that computers came to Africa as prestigious tools, as elite, sophisticated tools and not as non rocket signs. This is a myth that came with them. Computers are just ordinary technology, much easier than automobile and more

powerful than automobiles, because they are all knowledge based. Knowledge based technologies transform individuals. Many have a lot of interest in them. The West pushed computers as tools for private sector. That this is not true was not understood by the Government …It all depends on how you look at things within your own country… This element of articulation is what we need to do. We have to do a lot of trying around, pilots, a lot of talking with people."

The expansive force in the wireless telecom sector shows how high an ICT potential can be in Tanzania. We face an almost technical revolution experienced in Tanzania by the implementation and use of mobile phones with prepay function. Such a technology for direct communication between people seems to be appreciated as appropriate, relevant and affordable by a larger group of people than the income strong elite. Like in other African countries, mobile phone use has rocketed in Tanzania. Estimated market penetration rates in Tanzania's telecoms sector 2015 was for mobile 75%, fixed line 0,3%, internet (3G, 4G) 26%[161].

Emerging innovation system in a Mkukuta[162] context

ICT is a strong driving force for a number of transformation processes in societal development. In this chapter I have tried to focus on ICT as a trigger for making the role of university in a postcolonial context crucial and for the university to be understood as an equal partner in economic, technical, cultural and political transformation in society. Focusing ICT also enables us to realize potentials in building innovation systems – a capacity building, which must be done with a context sensitive approach. More specifically I have tried to elaborate the role of the technical faculties and other ICT related bodies at UDSM, as they are in the core of the whole ICT process.

A number of stakeholders are involved in making things happen indicating the issue of ICT to be much more than a question of technical infrastructure and technical systems, particularly when entrenched in emerging innovation systems. Experiences from Tanzania show how the introduction of ICT for instance in the form of Internet communication is a delicate process of technopolitical as well as more general political dimensions. Technical faculties and top management at the universities have been active and initiative taking partners. However, in the complex web of material, cultural, social and economic actors[163] within ICT development, one of the key issues is accessibility for low income countries and poor women and men. Opening up for and increasing access to information, knowledge and communication via ICT is a non-linear process.

A postcolonial situation emphasizes the concern of relevance. The Vice Chancellor of UDSM is explicit about relevance as the central mission for the assignments of the University – research, teaching and services to the communities. To be relevant in a bigger context than the traditional "ivory tower" context of universities means a number of challenging impacts on the university and its transformation ambitions. This huge issue is fully recognized in the context of developmental universities and mode 2 research practitioners. The recognition is met with forceful resistance by the university establishment in the West - as expected. However, our increasingly complex realities

[161] http://www.budde.com.au/Research/Tanzania-Telecoms-Mobile-and-Broadband-Statistics-and-Analyses.html?r=51 retrieved 20160419

[162] Mkukuta is the poverty reduction strategy of Tanzania.

[163] For a discussion of diverse actors in ICT contexts, see Elovaara 2004.

in a globalized world are there and cannot be denied. A postcolonial country like Tanzania has advanced potentials to meet the challenges of relevance and be in the forefront when it comes to the transformation assignments all universities face in a knowledge and technology dependent society.

If we use the triple helix model just as a simple way of recognizing the cooperating practices, where the university has one of the active roles, the relation between the university and the Government becomes a complicated balance act. This balance act is different in many but not all aspects from the situation in for instance Sweden and is due to the history of universities in former colonized countries. The situated knowledge about UDSM is carried by Luhanga et al. (2003a,b) and is an imperative reminder for me and others of the vital importance of context dependence of every effort of ICT development and knowledge system transformation.

A fourth actor, beside the three main actors, university, industry and government, in the triple helix model for technology development, has been recognized in "technology-related intermediary institutions"[164]. This forth actor points to the importance of a broker function. The broker role including knowledge management is often overlooked in the processes of cooperation between industry, university and government, not the least in a north European context. It is interesting that this function is identified at a Tanzanian context and strengthened by the account that the institutions of higher learning, such as universities, have a major role to play in generation of knowledge that enables smooth functioning of the actual cooperation processes. We find the vital broker and the linked transforming functions also within the main actors and as noticed at CoET and other parts of UDSM in the first decade of 2000.

The ambitions of UDSM and the Government of Tanzanian (in the National ICT Policy) to foster ICT for poverty elevation and societal development were (are) serious and have a recognized steerage-way. Acknowledging the postcolonial context hold vital potentials for innovative advantages as well as turning the western ICT expert discourse upside down.

[164] Emphasized by the Minister for Science, Technology and Higher Education of Tanzania 20040218 at the Regional Conference on Innovation Systems and Innovative Clusters in Africa, Bagamoyo, Tanzania.

Chapter 13

The concept postcolonial ICT is for me almost similar to ICT4D (ICT for development). I am interested in the becomings of postcolonial universities on their own terms in a global context. I am inspired by and using postcolonial thinking without being a trained scholar in the area. I keep to the postcolonial as my preferred concept in this chapter.

The UN world summits put specific attention to the evolving information society[165] and performed not only one but two summits in this field – WSIS 1 in Geneva 2003 and WSIS 2 in Tunis 2005. The digital divide and gender issues were high up on the agenda fostered especially by WSIS Africa regional chapter. It is within the context of these issues this chapter also include shortly a story of e-learning research and development in Tanzania.

I am most grateful to my colleague Birgitta Rydhagen, whose voice in the text is crucial and for allowing me to use her participating material in this chapter.

Postcolonial ICT - feminist technoscience and technopolitics intertwined[166]

> *we may never have been modern,... but some of us have certainly been more colonized than others* (Redfield, 2002: 795 [referring to (Latour, 1993)]).

Feminist ICT research

Feminist technoscience with emphasis on ICT is certainly motivated by transformation goals. The reasons for transformation are not only seen in the ongoing difficulties of achieving appropriate ICT system solutions especially in low income countries[167], but in the way we face contemporary processes of knowledge and technology development (Gibbons et al. 1994 and Novotny et al. 2001). The prerequisites for the latter are still to be met, and urge for transformation not the least within academy and faculties of technology (Etzkowic & Leydesdorff 1997). Academic ICT and its applications in society and every day life force our attention towards the relation between dominating actors, of which the university is one. It stresses relevant knowledge about its prerequisites resulting in transformation challenges within the traditional universities. Feminist technoscience within faculties of technology is a driving force fore the transformation processes in demand (Trojer 2002). The reason why, is to be found in the identified potentials of feminist ICT research, which meet some of the prerequisites for the discussed challenges namely the potentials to:

[165] WSIS - World Summit on the Information Society

[166] This chapter combines presentations made at conferences in Luleå and Lund, Sweden as well as in Geneva (WSIS 1) and written in Rydhagen, Trojer (2004).

[167] See for instance http://www.itu.int/ITU-D/gender/GenderWSIS/documents/list_documents.html

- expand the knowledge frames and practices for technology development in increasingly complex realities.
- develop epistemological infrastructures relevant for a society heavily dependent on research and technology.
- create explicit cultures within technology related institutions at the universities (phase out "the culture of no culture") and thereby make clear that no research positions are innocent.
- create driving forces for inter- and transdisciplinary constellations.
- open out preferential rights of interpretation in selections of standards, which always are reality producing activities.
- indicate alternative directions of ICT applications.
- establish new arenas for developing understandings of relations between research and politics.
- constitute a catalyst in the negotiations between, or better co-evolution of, science and society.
- contribute with competences for situating knowledge and for context dependence concerning resource allocation from high income to low income countries.

Vandana Shiva once said "New technologies travel on old social relations"[168]. Experiences reveal that new technologies simply reinforce old social structures rather than transforming them. This means the discourse of ICT as a universal tool is highly questionable - a tool, which also must include the possibility to change deeply ingrained structures like gender structures,. The concern to understand the underlying cultural and cognitive structures, which are reality producing in the evolving information society, has been and still is comprehensive in feminist technoscience.

Participatory ICT design is emphasized in feminist research as well as in human work science, computer science and elsewhere. Birgitta Rydhagen (1999, p.75) regards the feminist understanding of power relations and their impact on the production of knowledge and technology as highly relevant in participatory research and technology design. Combining participatory ICT design and feminist research promotes:

- diversity potentials as strategies to handle non consensus situations
- enforcement of situated knowledge and technology development (Haraway, 1991, Gulbrandsen 2004)
- emphasis on the importance of power relations and their impacts, including complex understanding of gender structures
- process-oriented development through a broader understanding of transformation processes.

An example is given by McKinley & Jensen (2003), who have studied the emancipatory and participatory potential of a radio program. The purpose of the program was to address women's health issues in remote rural areas in the Peruvian Amazon where a majority of the indigenous population lives. The listeners were encouraged to send in their stories and questions, which were then raised in sociodramas, answered by experts or investigated through interviews. Listener groups

[168] Lecture at Luleå University of Technology, March 5th 1998.

were also invited to produce the different programs together with the producer team. It turned out that both women and men listened to the program in single-sex groups (and not individually) in the villages. The producer received hundreds of letters from women, telling their life stories and raising specific issues of sex abuse, household violence etcetera. Through the radio, the women in these remote areas succeeded in connecting to each other, communicating about for them important issues with a radio studio as moderator.

Christina Mörtberg (2000) holds that equal access to ICT ought to be a basic principle, when the slogans are no longer "technology in a democratic society" but "democracy in an information society". She problematizes the discourse of equal access by showing the limitations of equal access rendering visible by a multiplicity of variables such as gender, class, race, religion, etc. "There are no automatic links between the political goal of equal access and the opportunities that are opened up by information technology."

Postcolonial ICT

Developing appropriate and relevant technology (system) solutions is a complex and context dependant issue and worked up in many technology fields (Rydhagen 2002).

The need for understandings of postcolonial ICT emerges, when ICT development issues are situated in the context of knowledge- and technology co-development between low and high income countries[169]. For development the change of position from merely technology transfer to co-development is strongly in demand.

Referring to Harding (1998) postcolonialism is not monolithic. The term has many referents and meanings. Temporally, it indicates the period beginning in the 1960s, marking the end of formal European colonialism.

The postcolonial context in sub-Saharan Africa seems still to be characterised by a lack of leadership and understanding of new technologies, political instability and weakness in the regional institutional building, several basic issues to address, and a need for ownership[170]. The imbalance in power remains, and makes it difficult for the postcolonial nations to define their own visions without having to rely on the intentions of donor nations and organisations. The colonial and postcolonial efforts to retain or change power relations affect the technological development. "It is not coincidental that the growing division between the techno-literate and the techno-illiterate replicates old models of hegemony and oppression, as evidenced in the use of terms such as information neo-colonialism and technological apartheid" (Mejias, 2001, p. 212). It is therefore necessary to investigate and de-naturalise the discussion of former colonies as nations in need of ICT transfer. As Albert Nsengiyumva has stated[171], all electronic technologies have been brought in from outside.

[169] An example of exploring the case between critics and proponents of information and communication technology for development (ICT4D) is given in Oppenneer (2009).

[170] Indicated by Albert Nsengiyumva already in a workshop 23/10/2003 at Blekinge Institute of Technology, Sweden.

[171] In a workshop 23/10/2003 at Blekinge Institute of Technology, Sweden.

E-learning in rural secondary schools in Tanzania

In Tanzania, secondary schools face a shortage of educated teachers, especially in the rural areas, as educated teachers tend to move to the urban areas. The problem is particularly severe in the science subjects as teachers in science find alternative, more profitable employment. At the University of Dar es Salaam (UDSM) and the Colleges of Engineering and Technology, a research project was developed during the time period 2005 to 2012. ICTs was tested as a tool to support rural secondary schools with teaching materials for the science subjects (Kalinga 2010, Lujara 2010, Simba 2012). The University of Dar es Salaam has a strong demand to focus research and education on areas of benefit to the wider society. The e-learning project was well in line with this ambition. The use of open source software (OSS) for the platform and the participatory content development and use were vital for the project.

During the research process, a more complex understanding of the participatory aspects of e-learning was developed. Secondary school teachers were participants in the initiating phases and when the material was developed. The e-learning material allowed for more or less participation among the students in the schools, depending on the structure of the platform and the content. The actual participation in the schools was depending on the preparedness among teachers and students to change the education context towards a more interactive mood when the e-learning material is introduced.

A number of institutions in African countries have taken up the challenge to address the Digital Divide. Already in 2001 the Regional Workshop on Engineering and Technology in Bagamoyo, Tanzania[172], researchers from East African countries identified common interests to find ways to develop ICT for use in rural areas in the different countries. The argument was that urban ICT has advanced much easier. Appropriate applications were identified for rural citizens include e-learning, medical advice, agricultural advice, promotion of the farmers' agricultural products and education through local computer centres in rural areas. This reduced costs for travels and increased the accessibility for rural citizens to expertise located in urban or distant rural areas. In addition, e-learning can address practical and local knowledge sharing outside the formal education system.

At the WSIS Africa Regional Conference[173], the participants identified a number of technical aspects of specific relevance for the use of ICT in African countries. These include African languages and voice/touch screen applications, free software and development of content suited to local needs.

At the same time as the postcolonial universities take on a role to develop ICT systems in their respective nation, the conception of the postcolonial has been problematized. Although legally, the nations have become free, the international relations still remain the same in many ways. People and institutions feel they continue to be in the position of receivers of financial and technological resources as well as development plans and knowledge (Trojer, 2004). The situation of ICT introduction and development in a postcolonial context thus needs to be discussed in terms of postcolonial theory, if ICTs are ever going to be(come) tools in and for the development of

[172] Regional Meeting, Engineering and Technology for Sustainable Development in Africa, Bagamoyo, October 17 – 21, 2001, UDSM, UEM, MU, UZ, Sida/SAREC, http://www.nusesa.org/Newsletter/Highlights.html [read 20040310].

[173] Bamako, Mali 28-30 May 2002. Summary at http://www.geneva2003.org/bamako2002/docs_word/Dec_bko2002_en.doc [read 20030312].

independent postcolonial societies (see Rydhagen, Trojer 2004).

The theories of postcolonialism have been criticised for not worrying about the material (see e.g. Kapoor, 2002). However, technologies producing realities will need to be included in the postcolonial theory, as the technologies interact with the human beings and societies in the determination of direction for future development (Anderson, 2002 and Mejias, 2001). In previous research, a number of issues relating to ICTs in postcolonial contexts have been discussed (Rydhagen, 2004). The introduction of a specific ICT in a certain location has very specific meanings and implications. In societies where oral communication and/or collective identities dominate, computers and the internet have very different connotations than they have in the literal and individual societies, where they were developed. Computers can be regarded as taking time from social interaction, thus being a negative thing. Similar, the language barrier to the internet for people with other first languages than English is both real and symbolic (Leonardi, 2003).

Some information systems are successful in one aspect, but regarded as negative or failed in other aspects. The employees might for example find the system useful for informal (but still work) purposes, while the usefulness is not reflected in increased income and thus not successful on management level (or the opposite). Gender and other social relations are affected by ICTs, but not necessarily in a way that resembles previous experiences in other parts of the world (see e.g. Apffel-Marglin & Sanchez, 2002). Technologies as such, as well as the way they are introduced and by whom will have effects on the impact ICTs will have in a postcolonial context. Old computers can be regarded both as 'good enough to start with' and 'something the rich countries want to get rid of anyway'. In what way this is going to be taken into account in the closing of the Digital Divide is still to be explored more extensively.

Postcolonial technoscience

Anderson argues that "a postcolonial perspective suggests fresh ways to study the changing political economies of capitalism and science, the mutual reorganization of the global and the local, the increasing transnational traffic of people, practices, technologies, and contemporary contests over 'intellectual property'. The term 'postcolonial' thus refers both to new configurations of technoscience and to the critical modes of analysis that identify them" (Anderson 2002, p. 643). The development of postcolonial technoscience includes the study of how technologies travel, how ideas about difference act on technoscientific practice as well as a focus on the commercialisation of science and intellectual property. The implosion of the two - postcolonial and technoscience - will not only show how Western technologies travel outside the West. It will also destabilise Western technoscience at home (op.cit.).

Who is actually postcolonial, and what does it really mean in relation to the past? In her paper "Globalization meets Frankenstein? Reflections on Terrorism, Nuclearity and Global Technopolitical Discourse", Hecht (2003) elaborates on the 'post-ness' of the 'post Cold War' and the 'post-colonial'. "The infrastructures and discourses of Cold War technopolitics continue to shape the parameters of global and local action, just as the infrastructures and discourses of colonialism do. We ignore those roots – and the contradictions they produce – at our peril" (Hecht 2003, p. 7). In addition, Morley and

Robins (1995) argue that if the ”post-ness” builds on a sense of dislocation, hybridity or displacement, these senses are new only to Europeans and white North Americans. For the colonised people in the world, the experience of fragmented realities is not new. With these perspectives, the postcolonial should be interpreted rather as a gradual change with many similarities with the past, than as the rupture that it is often argued to be. The similar could be said about ICTs, which in many ways as mentioned are ” travelling on old social relations”.

The images that reveal themselves on the internet and web sites are important, as the internet is an important arena of negotiation of the ”global identity crisis” that globalisation has brought with it (Fürsich & Robins 2002, p. 204). With reference to the local and contextual understanding of the world, the nature of the internet is not just a global blanket spread over us all, but a myriad of localities that are no longer entirely geographically local. Still, they are local, which is especially understood when the language is not English, but obviously, English, too, is local. The content of each web page is not of universal interest, but of interest to a specific group of people.

Global technopolitical discourses

Insights into the context dependence of technological applications are increasingly recognised in theory and in policy, but it is still often overlooked in practical applications. The reason is a lack of recognition that the actual technology is not a neutral device allowing the user to choose his or her own way of using it according to the local understandings. The actual difference in local understanding and preconditions is also often underestimated. The colonial time has indeed spread European ways of doing things, but these ways have also been adjusted to the local context. In Suchman’s (2002) account, the perspective from locations outside the West magnifies the situatedness and the fluidity of technologies, although these are actual within the western context as well.

Paraphrasing Donna Haraway, Suchman (2002) argues that the design from nowhere is a result of the idea that technical systems can be constructed with a minimal cultural connection ”as commodities that can be stabilized and cut loose from the sites of their production long enough to be exported en masse to the sites of their use” (p. 140). Suchman (2002) calls this phenomenon ”the fallacy of the empty vessel”; ”mistaking one’s own ignorance of what exists elsewhere – knowledges, information systems, practices – for their absence” (p. 140).

To complicate the discussion further, Suchman problematizes the distinction between designer and user, pointing both to the designers as users of their own products, and to the invisible design-in-use often taking place without rigorous documentation. ”Even to keep things going on ’in the same way’ in practice requires continuous, mundane forms of active appropriation and adaptation of available resources – discursive and material – to the circumstances at hand” (Suchman, 2002, p. 143).

Although local understandings and practices will influence the appropriation of ICTs in the postcolonial in different and unpredictable ways, the position of ”having never as much” (Redfield, 2002, p. 810) will for a long time be the position from which people in the low income countries will receive ICTs. Redfield showed what reactions and tensions this position may create. Are ICTs yet another way of imposing control, of deciding what is important to know and to have, of showing

who is in charge of globalisation? Are they yet another demand on transfer from national to private and commercialisation of common goods? A tool ”to make the poor dream the same dreams as the rich” (Martín-Barbero 1993: 165)?

Chapter 14

The message of situated knowledges, mode 2, NetPort as an innovation system was spread to Uganda and the Faculty of Technology at Makerere Universuty. The carrier of the message was Dr Peter Okidi Lating. Our cooperation started in issues of locomotives and ended up, so far, in Faculty of Technoscience at Muni University in Uganda. That story needs a book or two of its one. The following chapter is about what one person – the one just mentioned - with an extraordinary driving force, strategic skill, good heart and reliable networks can bring about in a traditional academic context but with a mode 2 approach.

From e-learning to university development in rural Uganda - co-evolution in triple helix processes[174]

To meet the needs

This chapter is focusing on the development of an ICT/GIS[175] research centre in Arua district, Uganda, as part of an e-learning research project and linked to the Vision 2025 of Uganda[176]. The Vision 2025 of Uganda has guided and influenced the development of the Poverty Eradication Action Plan (PEAP), its revisions and other government programs. It captures a technologically advanced, competitive, self-sustaining and growing economy; a healthy, well educated society with high quality of life; regional integration and international co-operation; harmonious coexistence within a dynamic society where citizenry is responsible, accountable, hardworking and peaceful; effective, participatory and democratic governance; equal opportunities, empowerment and poverty eradication among people.

The implementation of ICT in Uganda is not a question about solely technical transfer from other continents.

> *Unfortunately, many technological solutions deployed in Africa at large are uprooted from developed countries and in the best cases modified to meet the needs of nations, and in most cases implemented as it is and left to decay before ever been fully utilized.*

[174]This chapter is combining parts of 2 papers, namely Peter Okidi-Lating, S.B.Kucel, Lena Trojer (2007) "E-Learning for Development in Rural Uganda: Co-evolution in Triple Helix Processes", conference paper, the Conference on Collaborative Research for Technological Development - Kampala 17th - 21st December and Lena Trojer, Peter Okidi Lating (2011) "Gender Research as Knowledge Resource in Technology and Engineering" in Proceedings of 2nd International Advances in Engineering and Technology Conference of Makerere University, 31st Jan-2nd Feb, Entebbe-Uganda, Macmillan Uganda Ltd.

[175]ICT refers to Information and Communication Technology and GIS refers to Geographic Information System.

[176]Uganda vision 2025 Prosperous people, harmonious nation, beautiful country: a strategic framework for national development. Kampala: Ministry of Finance, Planning and Economic Development, 1999.

> *Therefore, African countries need local technological innovations to meet the needs of its people.* (Mwamila et al. 2004).

Gulbrandsen (2004) states "that technology development is one of those things which cannot be left to be stirred by market forces alone because of the possible occurrence of the market failure phenomenon and other externalities, which are beyond the control of innovating firms and farms, especially for the less developed countries. Thus, there is a need to inhibit market failure effects by putting in place policies for technology development as well as on the ground collaboration between academia, industry and government for innovation development".

The chapter takes into account a specific aspect of the development of an e-learning project in Arua district in the North Western part of Uganda, in the West Nile region and in a co-evolving context. It is a particular challenge to practice a multi stakeholder process in Arua as Arua is a remote, insecure and one of the poorest rural districts of Uganda. It is approximately 500 kms from Kampala, the capital of Uganda. The district is home to many Sudanese Peoples Liberation Army (SPLA) refugees. Going to Arua is fairly difficult because the road passes through Acholi land where the Lord´s Resistance Army (LRA) rebels can be active. Being very close to the Democratic Republic of Congo (DRC) skirmishes close to the boarders frequently spills over into Arua district.

The pre-story to the e-learning project and its geographical location to Arua started in 2002. A fourth year electrical engineering student at Faculty of Technology (FOT) [177] at Makerere University (MAK) conducted her project on rural ICT sustainability in Uganda. She found ICT Centres to be viable in three rural districts in Uganda - Arua, Bushenyi and Busia.

The main part of the R&D work in this e-learning project is based on the methodologies characterising distributed knowledge processes (Gibbons et al. 1994, Nowotny et al. 2001). The research was anchored in the tradition of action research methodology (Schön 1983) and nowadays referred to as interaction research as well as feminist technoscientific (Trojer 2006).

Situated e-learning

In March 2004 an ICT/GIS[178] research team from the Faculty of Technology visited Arua district to follow up on the findings of the engineering student mentioned above. The follow up was further supported by a researcher at FOT, Dr Peter Okidi Lating, started a study in 2004 out of the questions why there were so few female students at FOT and why so few students – males and females - at MAK coming from secondary schools in rural areas. More than 80% of Uganda inhabitants of about 35 million people live in rural areas and over 90% of the few female engineering students were in 2004 from the 'elite' and advantaged urban schools located in Kampala and its surrounding Districts of Mukono and Wakiso.

In order to illustrate how situated knowledges and results can occur, we need to go into details.

[177] later became CEDAT, College of Engineering, Design, Art and Technology at Makerere University.
[178] see footnote 176

The team met District leaders, Heads of Departments, Head teachers of secondary schools, officials of the District Chamber of Commerce, the Business Community and Women groups. The team also visited Kuluva hospital and some sub-counties in Arua district. Everybody supported the idea of FOT setting up the ICT/GIS Research Centre in Arua. In October 2004 the ICT/GIS team led by professor Tickodri Togboa visited Arua again and addressed the District Council and told them the intention of FOT to set up an ICT/GIS Research Centre in Arua. The District Council supported the idea. In March 2005 the team looked at premises to rent before starting up the ICT/GIS Research Centre and held meetings with local government officials, especially the Acting District Chief Administrative Officer and the District Information Officer. The team also visited Internet cafes and FM radio stations in Arua. At the end of April 2005 the ICT/GIS team applied for the former Chief Magistrates court buildings in Arua city to be given for use as the ICT/GIS Research Centre. The application was brought to the attention of the District Council, which approved it. The core activities of the e-learning project were now situated at a specific place, from which a number of different learning processes took place.

The main target group for the e-learning project were two advanced level (A-level) girls secondary schools, Muni and Ediofe, and an Ordinary-level (O-level) girls secondary school. This was agreed upon after the researcher Peter Okidi Lating met the District Education Officer in Arua March 2005. Hybrid e-learning tools were developed and implemented. Hybrid e-learning in the context of the project means e-learning, where the main course delivery platform was interactive multimedia CD-ROM and where face-to-face traditional classroom teaching remained. The main reason for an ICT centre (the ICT/GIS Research Centre) in the project was the financial situation in both the secondary schools. Resources for the operational costs of sustaining internet connectivity were not available. A decision was made to deliver content in CD ROM format to the schools and set up an ICT Centre with VSAT internet connectivity[179] within the vicinity of the two schools.

In spite of the different approaches of the respective headmistresses of the two secondary schools - not so much to the project as such but to the girl students participating in the project - the girls students were enthusiastic. A number of notable situations happened with the girl students and their teachers during the project. As a very concrete result the analysis of the e-learning project showed 41% of the students in the final year (A-level) passed and were eligible for university admission compared to 0% before without the e-learning tools for girls born and living in Arua (Lating 2009).

The development part and the implementation of the project took place in a parallel process including setting up the ICT/GIS Research Centre in the middle of Arua town. The Centre was opened in June 2006 to the public. A network administrator and a secretary were recruited. ICT coordinators from secondary schools were identified and trained as trainers. Ten second year telecommunications engineering students from FOT were used as teachers. They did their industrial training at the Centre. Up to 1250 people were trained during the period June - August, 2006, in basic ICT skills, internet use and working with e-mails. These included District heads of Departments, secondary school teachers together with their students and the general public.

[179] This expensive connectivity was the only function available in the start. Some years later mobile internet connectivity had reached Arua and became a cheaper alternative.

University as Triple Helix stakeholder

As mentioned above the e-learning project was positioned in an open system for knowledge and technology production. The triple helix model was practiced in Arua, where one of the three cooperating partners was the university. In developing, as well as in developed countries, initiatives for introducing e-learning education most likely come from universities, where we find the skills from higher education including pedagogic skills and the technical knowledge and know how.

Even in a low income country like Uganda the university has resources, which not the other triple helix stakeholders might have to the same extent, namely to

- take initiatives
- network on vital levels
- negotiate with authorities, donors etc.
- offer facilities
- develop knowledge and technologies needed
- develop and offer training
- long term engagement
- keep the functional practices and cultures, which have been developed, in spite of fragile political situations.

The co-evolving processes in the project, in which the Faculty of Technology at Makerere University took a substantial part harmonized very well with the third core mission of a university, which in Uganda is formulated as service to society. This mission is strongly linked to the national policy of Uganda in the Poverty Eradication Action Plan.

The initiatives taken and implementation performed by FOT in order to build the fundamentals for the e-learning facilities in Arua are presented and discussed in detail in Lating (2009). The detailed stories what really happened in Arua, i.e. rich sources of situated knowledges can be found in Lating (2011).

Government / public sector as Triple Helix stakeholders

The governmental / public sector stakeholders in the e-learning project were:

District and local government officials

1. Regional District Police Commander's Office
2. District Police Commander's Office
3. Chief Administrative Officer's Office
4. District Medical Officer's Office
5. District Forestry Office

6. Resident District State Attorney's Office
7. District Information Office
8. District Engineer's Office

Schools

1. Muni Girls Secondary School
2. Ediofe Girls Secondary School
3. Mvara Secondary School
4. Arua Public Secondary School
5. Arua Public Primary School
6. Uganda Christian University, Arua Campus
7. Arua Vocational Training School
8. Arua Core Primary Teacher's College
9. St. Joseph's College Ombachi
10. Anyafio Role Model Secondary School

Hospitals

1. Arua Hospital
2. Maracha Hospital

Other Governmental Institutions

1. National Social Security Fund (NSSF)
2. Northern Uganda Social Action Fund (NUSAF)

The numbers of governmental, public stakeholders is impressive and quite unique compared to a Swedish regional context. This fact is a strong sign from the stakeholders for an acknowledged relevance of the e-learning project and its impact in a place like Arua district.

Business sector as Triple Helix stakeholder

Thanks to a qualified anchoring process of the FOT team the business sector of Arua district has been involved in the project. The ICT/GIS Research Centre is offering facilities much needed. The District Chamber of Commerce has been cooperative. The following companies were concerned

West Nile Rural Electrification Company (WENRECo)

Uganda Breweries

Private Sector Initiative (PSI) Uganda

Sumandura Construction Works

Boniface Television Networks

Nile Fm / radio station

Arua One Fm / radio station

Copcoot Uganda /

Westnile Distilleries

Heritage Gardens- hotels business

Multitech Uganda- ICT training business

Kuluva Hospital

Marie Stopes Uganda –Reproductive health provider.

Other Triple Helix stakeholders

Besides the three main stakeholders mentioned above the project and its facilities have also involved other stakeholders and interested partners and individuals. They were

NGOs and CBO's

Netherlands Development Organisation (SNV) Uganda

United Nations High Commission for Refugees

DED /(Community Based Organisation)

Cream Uganda (Community Based Organization)

PAD (Community Based Organization)

PRAFOD (Community Based Organization)

CAFECC ((A Sudanese Community Based Organization)

World Vision Uganda

WENDWOA (A women organization helping widows and helpless children)

Right To Play

NSEA / Needs Service Education Agency >

Others

1. Researchers
2. Students doing online courses in and outside Uganda

3. Visitors to Arua
4. Traveling Agents
5. Students from schools outside Arua District mostly during holidays
6. Community workers
7. Indigenous people who mostly use the internet for communication with their relatives and friends in and outside Uganda.

The Centre trained students from West Nile Districts, South Sudan and Democratic Republic of Congo. District leaders from other Districts in West Nile (Koboko, Yumbe, Nebi, Adjumani, Moyo) came for the training on weekends.

Arua and impacts

The decision to put up an ICT centre had a huge impact of not only the town and its surrounding districts but also to municipalities on the other side of the nearby border with the Democratic Republic of Congo and Sudan.

The number of stakeholders is impressive and quite unique compared to a Swedish regional context. This is a strong sign from the stakeholders for an acknowledged relevance of the e-learning project and its impact in a place like Arua District (Lating et al. 2007).

In 2010 the Uganda Government decided to start establishing a new university in Arua - Muni University. The ICT/GIS Research Centre is one of the seeds for starting the development process of the university. Muni University was established as a Public university in 2013 by Statutory Instrument, 2013 No. 31, in accordance with the Universities and Other Tertiary Institutions Act 2006 as amended. The first faculty developed is named Faculty of Technoscience.

Institutional systems are full of fuzzy areas and things between the lines that are difficult to grasp, activate and study (Haraway 1997a, Argyris 1991). To work in processes including culturally different institutional systems like government, academia, private sector amplifies these challenges. The contributions towards a functional and sustainable system, which the Arua project illustrates, underline conditions required by good learning environments and learning processes. The open minds of the actors involved, a jointly identified goal and presence of the actors in the context of application show it is possible to learn and co-evolve.

There are always challenges in a triple helix process, and the one in Arua is no exception. The main ones refer to the following.

I. There is a policy gap existing in Uganda as there is no policy concerning e-learning and ICT integration in school curriculum. The capacity for ICT skills and pedagogic development is very low among teachers and school leaders. The ICT/GIS Research Centre had to start with very basic skill development of teachers and other staff.

II. Some district leaders did not see the relevance of the ICT/GIS Research Centre from the beginning and did not accept it. The time is a quality here. Repeated meetings and discussions had to

be conducted. When the centre was in place and could demonstrate its objectives and facilities concretely it was easier for the district leaders to understand and appreciate its advantages.

III. The issue of misconception is a critical one. One district information officer kept on interpreting the ICT/GIS Research Centre as belonging to his governmental department. He appeared in the centre and gave directives to the centre staff. This highlights the mission of the centre to be a neutral arena and sustain that neutrality. The centre is clearly a non profit organization, however, struggling very hard to find ways to be long-term sustainable.

IV. The challenges linked to the business sector have been minor. One reason might be the good relationship with the Mayor of Arua town, who was also the chairman of the Chamber of Commerce.

The paramount result of the collaboration of the university, district and local government and the business sector in Arua is the ICT / GIS Research Centre. The project has shown exceptionally good results in an unexpected short time.

What are the success factors? One of them is the frame of understanding in the triple helix model, which has been translated into practical work in Arua district. The internal university process, more precisely among the participating researchers and teachers from FOT, is characterized by moving from strict disciplinary research to interdisciplinary research and further on to transdisciplinary research and development. The understanding of transdisciplinarity is here including knowledge production in the context of application and implication. The triple helix process will not start working without a very important function, which constitutes a broker or facilitator. That person must have trust among all the main stakeholders and be able to move around in all sectors, anchoring the project, get people moving etc. In this e-learning project that person has been the researcher Dr Peter Okidi Lating from FOT.

The mindset of the involved partners seems to be changing from linear development mindset to collaborative development mindset. This transformation of mindsets is a condition for a triple helix process in operation. Another way of expressing the relation between the stakeholders is a change from strict contract negotiation to co-evolution.

Increasingly open systems for knowledge production require a focus on the direct reality-producing effects of research – its context of implication (Nowotny et al. 2001). According to Donna Haraway (1997b, p. 68) there is neither time nor space to develop reserch's relations with society "… after all the serious epistemological action is over". Neither sustainability nor other values that we would like to realise can be secured retrospectively. Our technoscientific research is positioning its projects and work to promote more complex and integrated understandings of the relationship between research and society in this grey area that Nowotny et al. (2001) ascribe to a dedifferentiation of the social spheres of modernity.

Chapter 15

Emerging innovation system efforts are interrelated with the ICT development as indicated in the chapters above. What kind of contexts of implication is recognizable, if we put our attention towards the combination of emerging innovation systems and the role of the university in East Africa,? Cluster initiatives can provide such contexts. This chapter is filling cluster initiatives with some content from examples in both Uganda and Tanzania. The content comes from results of a research project focusing on the role of the researchers in innovation processes in cluster contexts. Involvement in clusters differ from traditional research, which has mainly been supposed to be disconnected from practice and also from consultancies, in which collaboration is based on exclusively economic interest. The aim of the project was to find out how research linked to clusters can be understood within the academic system as well as by partner stakeholders who are outside academia.

As both Birgitta Rydhagen and I are driven by situated knowledge production making sense in contexts outside the university and particularly in low income countries, our interests coincided in this research project. I am deeply inspired by our teamwork and grateful to be allowed to use the joint text below in this essay collection.

Innovative Clusters Closing the Gap between University and Society in East Africa: a living proof of Mode 2 excellence?[180]

Why clusters?

It has become a pan-African interest and engagement to foster the development of innovative cluster initiatives[181]. In 2008, the Pan African Competitiveness Forum (PACF) was formed to accommodate and coordinate national and regional networks for cluster initiatives that started a few years earlier (Mwamila 2014).

The major concern of cluster initiatives is to increase income generation and financial security for the vast majority of rural and urban population working with small scale business to support their families. Innovative cluster initiatives aim to bring up internal entrepreneurship in individual firms in close collaboration with similar firms in the same location and with academic researchers and government officials in a triple helix process. Research may improve technical processes, solve

[180] This chapter is a revised version of Rydhagen, Trojer (2011) Research report from Cluster Initiatives Lake Katwe Salt, Uganda and Zanzibar Seaweed, Tanzania. The research project was done with financial support from Sida project grant SWE-SP2010-005.

[181] See chapter 11.

ecological puzzles or facilitate management of marketing and sales. The involvement of government on national and local level increases opportunities to adjust regulation and adjust to regulations, solve disputes and develop supporting mechanisms like health services, public transportation or securing land rights for the cluster entrepreneurs.

Individual business persons join in "co-opetition" in the sense that they cooperate on solving problems they share or divide different aspects between them, while they continue to compete with their products on the market. Interested persons in research institutions and other relevant organizations are invited to become facilitators for clusters and to take part in training workshops arranged for this purpose. They work voluntarily with the facilitation, although some seed money have been available and used to initiate first process steps. Cluster initiatives are formed by the facilitator and a leadership group including local business representatives, government representatives from relevant departments and researchers.

Innovation and mode 2 research for sustainable development

Sustainable Development

In the early 1990's, the concept of sustainable development was dispersing through international organizations and national governments as an attempt to combine economic growth with social security and environmental protection. In its more radical sense, social, environmental and economic development are regarded to be interdependent and should therefore take place simultaneously rather than being compromised to each other. The most cited definition of sustainable development is a "development that meets the needs of the present without compromising the ability of future generations to meet their own needs"[182].

Almost a decade later, the United Nations formulated eight millennium goals (MDG)[183] in the same spirit, giving human and environmental development quantitative and time-limited goals to reach for. For example, the number of hungry or starving people should be halved (from 1990) before 2015. Also, the number of child deaths and death by women giving birth should be reduced. Increased gender equality is measured through representation in parliaments and girls' school attendance. At the same time, ecological sustainability should be improved by providing half of those without safe water and safe sanitation with these facilities, and forest cover in each country should cease to decrease. For countries with low GDP, efforts focused on the reduction of poverty and the provision of e.g. water. Several diverse efforts were required, and innovation to increase income generation in small scale entrepreneurship could be regarded as one of them.

In 2016 the MDGs was followed by the 2030 Agenda for Sustainable Development[184], the SDG with its 17 goals now concerning all countries in the world and not only the low income countries.

Innovation and triple helix model in low income countries

[182] World Commission on Environment and Development (1987) Our Common Future, Oxford University Press.

[183] http://www.un.org/millenniumgoals/

[184] http://www.un.org/en/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E

It has been argued that innovation is an important aspect of a nation's capability to improve economic situation and competitiveness (Lundvall et al. 2002). We can also argue that this is valid on an individual level, although the question then becomes even more pressing, whether competitiveness means some should remain inferior or be left behind in order to be able to achieve success. Within the PACF cluster development, the concept of has been developed to emphasize balance between competition and collaboration to avoid some of these negative consequences.

According to studies presented by Fu et al (2011) real and sustainable development in developing countries can only be achieved when innovation and technological development is domestic and locally driven. Innovation done elsewhere and imported in a ready-made form does not lead to further improvements or innovations in the context of application. Statistical comparisons have shown that FDI (Foreign direct investment) in developing countries does not lead to development of local firms, since patent rights and knowledge systems discourage international firms from interacting with local companies. Rather contrary, it seems that FDI discourages local firms' investment in R&D since their competitiveness is low in comparison. Knowledge has been shown to spread in locally established clusters, where social bonds and trust through face-to-face interaction facilitate sharing of relevant and specific knowledge.

Fu et al also argue that the socio-economic context has effects on the type of innovations. In places with access to unskilled labour, technological innovations will be adapted to this, while high-tech solutions are developed when there is skilled labour available.

This is not an argument against international collaboration, but Fu et al insist on the necessity of local, indigenous innovation efforts to achieve appropriate technologies that can be adopted and diffused effectively and involve and train local labour. South-South collaboration is mentioned as an important issue in this aspect.

Therefore, support is needed to domestic firms and researchers, who have ideas and who are already in a process of production, construction and innovation. The Triple Helix model for innovation has been shown successful in this kind of contexts, since the interdependence between the key stakeholders government (focus on social and economic development on general level), universities (focus on knowledge development with social relevance) and private sector entrepreneurs (focus on economic stability and progress on individual level) is recognized and lead to more long-term benefits and stability (Rath et al., 2011).

An important aspect of the triple helix model is the nature of the collaboration. Interaction between researchers and local business has taken place over the years, both as a way to receive funding and as a way to distribute patents and other inventions. Kruss (2008) emphasizes that the particular component in triple helix interaction is that the participants share a focus on knowledge instead of on economic matters. That means firms are not in particular in need for a quick solution to improve their profit, and universities are not in particular in search for funds. Instead they develop a common interest in learning how to deal with a particular issue through testing and relating to other cases. This has a certain bearing for universities in East Africa, where local business can often not be expected to contribute substantially with funds, but where knowledge for survival and adjustment to basic circumstances is a necessity. In this context, researchers and local business people will together find essential knowledge faster than counterparts in more effluent locations.

In Kruss's study of different higher education institutions in South Africa, it also becomes evident that different institutions focus on different areas of knowledge and research. In remote rural, historically disadvantaged and young institutions, poverty reduction was in focus in connection to local population. This is potentially opening up for triple helix collaboration both to develop research capacity and to improve local business. Well established and well-resourced universities were more independent of local context and more focused on other kinds of partnerships.

With similar experiences, Nwagwu (2008) has argued that African universities, exemplified by Nigerian universities, are not well prepared for the third step of triple helix, since the equal level collaboration can become problematic. The governments in Africa have not taken the role suitable for triple helix, and the universities have not had research capacity to develop a culture of innovation and socially relevant knowledge. Instead, he argues, research has taken place in relation to international organizations and NGOs addressing internationally relevant issues with little effect on local development.

In the PACF context, private sector is in most cases very basic and small scale, often rural businesses with little investments and small, day-to-day income generation activities. Innovation in this context is not narrowly defined as technological development, but will also by necessity embrace organizational innovation such as the idea of co-opetition, sharing of methods with other cluster members, storage and transportation, marketing, exploring markets[185].

The universities in Eastern Africa are challenged to navigate between rigorous requirements for academic quality and demands on social relevance. As discussed earlier these requirements have been explored by Nowotny et al (2001), who elaborate Mode 1 and Mode 2 knowledge production in comparison. Holland (2009) argues that Mode 2 knowledge production in a developing country will challenge researchers to bargain between scientific rigor and independence on one hand and economically profitable consultancies on the other. Her concern is that Mode 2 projects are often ordered and paid for by a patron with requests for specific results that are proprietary restricted.

Two cases

What then can real practice of cluster initiatives look like? This chapter will focus on 2 cases. These were selected within the PACF network on the basis of the following criteria:

- Well established among the first pilots, in order to have extensive experiences both locally and on national level to relate to.
- Connection to the dependence and use of natural resources.
- Relevant components of gender and environmental sustainability aspects.

The two cases are located in Uganda and Tanzania, who were among the first to adopt the cluster model. In Uganda, Salt Lake Katwe was one of the first seven pilot clusters initiated in 2005. After

[185] See examples in e.g. Msuya, Flower E. (2011) Status Report of Cluster Initiatives in Tanzania, Report to the Pan African Competitiveness Forum, Tanzania Chapter.

taking part in facilitator training, Engineer Balu Tabaro, who is a retired geologist and engineer from the Ministry of Energy and Mineral Development, took the opportunity to introduce the cluster idea to salt workers around the lake, based on his previous geological investigations in the area. The cluster has formed a local leadership group in the village Katwe, representing salt workers (women salt winners and men salt extractors), salt loaders and salt traders. The local leadership group is in regular contact with facilitator Engineer Tabaro, and with local government on certain issues. Two researchers at Mbarara University do research on how to refine the salt to table salt quality. This work has partly been financed by Investment Company JDG Africa Ltd.

In Zanzibar, Dr Flower Msuya approached a women cooperative working with seaweed and with soap production, after she had been trained as cluster facilitator. Zanzibar Seaweed Cluster Initiative was one of the eight first clusters in Tanzania that started in 2005-2006, and has moved from pilot activities to a sustainable stage (Msuya 2010). The two major aims are improved seaweed cultivation and value-added products. The major activity among seaweed farmers is to cultivate seaweed in shallow water, harvest and dry it. It is then sold to export companies for use in chemical, food and medical industry in various countries. It is done on individual basis, but the Cluster Initiative is created with cooperatives and groups of farmers in different villages. Value addition is done for example through production and marketing of soap with seaweed. Improvement of cultivation has included attempts to grow seaweed in deeper waters with new technologies and to enhance the post-harvest drying process. Both aspects have been developed in close collaboration with researchers from IMS and have involved training of the seaweed farmers in each local group. Zanzibar government and seaweed exporters are represented in the leadership team. In 2013 the cluster included 3 000 members in 11 villages.

A detailed description of methods used in this research project is given in (Rydhagen, Trojer 2011).

Salt Lake Katwe

Lake Katwe is located in a crater formation with slopes covered with grass and low bushes surrounding the whole lake. The shoreline is 7-8 km long and the lake is no more than 1.5 meters deep.

In Katwe, it is reported in 2005 that 10,000 persons work with salt extraction from the lake during high season[186]. The number of permanent residents working throughout the year is estimate to be between 1,000-2,000 and the activity can be low due to rainfall. The salt is sold for industrial use and animal consumption in Uganda. Around 1,000 women own salt pans, a fenced pond along the shore where salt water is evaporated and remaining salt harvested. Their work consists of checking and mending fences, removing waste and dirt, remove sweet water after rains and scraping of salt and salt mud for harvest and sale. Women can also work as labourers in other persons' salt pans. A group of 130 men extract salt rock from the bottom of the lake outside the saltpans. The lake is shallow, and the men walk in the water, cut pieces of rock with an iron bar and bring it to the shore on floaters. On the shore, salt is weighed and paid for by women traders, who then sell it to buyers

[186] Lake Katwe Salt Cluster Progress Report October 2005 to June 2006 . Estimates vary between years, and during interviews, the number of salt winners working with the ponds had reduced due to low production.

from outside the village, who collect the salt on trucks. The salt is carried from the lake to the trucks by male loaders on their necks. Plastic is used to protect the skin from salt.

Salt loaders, salt extractors and salt traders are organized in formal organizations where some of the profit is kept for collective use and as security for those who are sick and cannot work for a period. The collective fund is used to pay hospital fees when a member is in need. Women salt winners are more in number and less organized.

There is no storage for salt. This means salt cannot be kept safe from rainfall or from theft. The salt workers therefore depend on buyers to appear regularly, and they accept the price suggested in order getting the salt sold.

During our focus group interviews, we asked the salt workers about their view of the cluster, and how the cluster could benefit them. According to several salt workers, the main activity until now had been to find ways to refine the salt. A major concern that the salt workers shared was to loose control over the salt as a resource and a source of income. They feared that external investors might introduce salt refinery but at the same time take control over the lake. Therefore, major suggestions for the cluster were to develop work conditions besides improvement or increased salt extraction.

Salt water is detrimental to the skin and to private parts of the salt workers. Wounds are sealed with glue or patex prior to entering the lake, and private parts are protected with pants made from rubber bags, sanitary pads filled with herbs and other local inventions. These protective efforts have not been successful, and the men extractors in particular ask for boots that protect the skin without causing overheating. Men loaders were searching for a durable material to put on their necks for skin protection.

The extractor group had started to construct a building to be used as a clinic. There was a desire to bring a mobile clinic nurse to the lake for consultation, as well as first aid equipment. This wish was forwarded to the local government.

Women salt winners complained that some men extractors were destroying their pond walls when they cut rock from the lake bottom. According to the men extractors, this was not done by purpose, but some non-organized extractors were working too close to the ponds despite regulations of a distance of ten meters. Apparently, there were regulations in place between the salt workers and within the groups, although not all were followed by all persons.

We were told that there was a major problem with rainwater and soil entering the lake. In part, this depended on increased rainfall during the last years. It was also explained that pan owners placed their pans in the way for streams for rainwater into the main body of the lake. As a result, the streams divert into the pond, causing dilution in the ponds. The women groups informed that destruction of the green cover around the lake had increased the water runoff and the erosion of soil into the lake. Cattle's grazing was regarded as one explanation, but also cutting of grass and bushes to mend the pond walls, and collection of stones and small rocks for house constructions. Reduction of the green cover around the lake was a concern, and there was a call for local government to reinforce regulations around cattle grazing and also for replantation of suitable species. In some groups, it was suggested that researchers should be invited to give environmental education and information to the

community members, in order to emphasize and legitimize regulation for grazing and conservation of the green cover.

In the leadership group together with facilitator Engineer Tabaro concern was raised that one of the facilitators and triple helix stakeholders, JDG Africa Ltd, had acted on salt refinement without informing them. JDG Africa Ltd is an investment company, and there is fear they will try to make a profit from refined salt rather than contributing to the Cluster Initiative for the benefit of the salt workers.

A chemistry researcher at Mbarara University explained that their research was funded in part by JDG Africa Ltd, but their intention as researchers was not to remove control from the salt workers through their innovations. He also told that he had visited Lake Katwe regularly for 2 years, each time taking samples and having meetings with the leadership group on different issues.

The Dean at Mbarara University Faculty of Science expressed commitment on behalf of the entire University to contribute to societal development[187]. For example, students in medicine and teaching were sent to training in rural clinics and schools with limited resources, in order to establish engagement among students and to make them aware of work opportunities available outside urban centres. Therefore, engaging in research with the Salt Lake cluster was regarded as positive and in line with the University vision. The chemistry researcher confirmed that research done with the cluster had been reported in academic conferences and he did not see conflicts between social relevance, concrete applications and academic quality and career development.

Zanzibar Seaweed

Around the coastline of Zanzibar seaweed has been harvested for many years. Two seaweed species rich in carrageenan are sold on export to food and hygiene products industry. Today, thousands of people, mainly women, cultivate seaweed on Zanzibar. The main work is to plant, protect, harvest and dry seaweed for sale to export companies. The seaweed cluster initiative was formed 2006 with aims both to improve cultivation and increase income through production of seaweed products locally. The cluster was initiated by Dr Flower Msuya, who was trained as facilitator related to her position at the Institute for Marine Science in Zanzibar Town. The institute is part of University of Dar es Salaam. Her first initiative was to introduce seaweed as a soap ingredient to a group of women making soap for a local market besides their seaweed farming activities. Adding seaweed increased the market value and visibility of their soap, which in turn increased their economic revenue and independency. Similar efforts were done in other villages, although with slightly different approaches. In Kidoti Village, women have soap making machines, while in Bweleo, soap is made by hand. Other efforts have been to access boats, since cultivation of the higher value species is more successful in deeper water.

Dr Flower Msuya is the driving force in the seaweed cluster and she keeps in contact with the cluster groups in the villages on a regular basis. She is also in contact with other members of the steering group consisting of representatives from governmental Department of Fisheries,

[187] See http://www.must.ac.ug

Department of Agriculture, and the private export company Birr. Direct relations with Department officials facilitate handling of certificates, conflicting interests in villages etcetera.

Seaweed is mainly cultivated by women and it is mostly women who are members of the cluster groups in the different villages. In two cases, a few men are also members of the groups. Women claimed during interviews that if they had male members, they feared that the men would not be honest, and would not work for the group but only show up when profits were to be shared. They were therefore satisfied with being only women in the groups. However, Dr Msuya argued they would benefit from including male members since seaweed farming requires male coded work like boat driving and diving. Women experienced that the work with soap production had given them a higher self-esteem and higher status in the community since they had a work to go to in the mornings apart from farming. Finances were improved for the individual women as well, since soap sale gave additional incomes for the women. Only a small share of the seaweed is used to produce soap and other seaweed products in cooperatives in a handful of different villages around the island, but the added economic value is important for the women.

Women farmers found a major obstacle for further development was marketing of the seaweed soap. They were also reluctant to develop deep water farming of the higher value species of seaweed, due to difficulties in boat driving and diving. Dr Msuya tried to encourage collaboration with men who could assist, as well as learning of the skills by the women themselves.

The heads of IMS appreciated the cluster initiative and explained that some professors at the Institute had previously been reluctant to interact with stakeholders outside academia. Today, all researchers were eager to communicate and collaborate with various stakeholders. Students were also given tasks involving interaction with other actors in society to learn the relevance and complexity of development issues even within natural sciences.

Co-opetition and social relevance

Clusters aim to increase competitiveness without leaving somebody behind. The practices of co-opetition intend to reduce the negative aspects while stimulating the positive aspects of supporting private firms within the same branch. It was evident in both cluster case that the Cluster Initiatives had brought buyers and producers in the local community into collaboration. This has been beneficial for both. In the Katwe Salt Lake Cluster Initiative it was evident that within the groups of loaders, extractors and traders, profit was divided equally and in solidarity with those in temporary need. There was a balance between collective sale and individual sale, which also occurred in the Zanzibar Seaweed Cluster Initiative. Individual sale of dried seaweed was done parallel to collective production and sale of seaweed soap for the benefit of the group and the group members.

We found a genuine interest and engagement in Mode 2 research with social relevance on all levels at both Mbarara University and Institute of Marine Science (IMS) in Zanzibar. IMS Deputy Director expressed that with the success of the cluster efforts Mode 2 research had permeated the Institute from professors to students, who were trained to collaborate and contribute with society during study programs.

It is our concern that Cluster Initiatives should not be merely consultancies with a financial focus, but should remain genuinely collaborative and mutually beneficial in terms of knowledge. In a triple helix process, where roles are blurred, research will benefit from knowledge sharing with local entrepreneurs and access to governmental information and collaboration.

With knowledge sharing in focus, we find a clear demarcation between Mode 2 research and consultancies. Financial dependency as Holland (2009) describes it is not the same as the shared interests evident in the Cluster Initiatives. There is no direct financial benefit for facilitators in clusters, since most of the work is voluntarily.

In the Katwe case, an investor has paid for the research and therefore extra attention needs to be paid to keep the salt workers in a central position regarding ownership of results and access to benefits coming from the research. Balancing between bringing in capital and loosing control is delicate, and may well lead to the failure of clusters in need of advanced and costly initial investments. In the case of Zanzibar, stepwise development has been possible since soap can be made manually as well as with the help of machines brought in at a later stage, and since dried seaweed is continually sold to exporters without further refinement at the local level.

Research in the cluster context was more visible and more beneficial when it was formulated as an interdisciplinary and transdisciplinary activity, as in the Zanzibar case. Both cultivation methods, technology for processing of the harvest and organization and marketing were addressed within the cluster. These issues were on their way to be brought up in Katwe case, but hitherto, chemistry had been mostly disciplinary research.

With reference to Fu et al, the role of PACF supporting cluster development in Africa seem to be highly relevant and important for the development of local and appropriate knowledge production. The establishment of cluster initiatives between local actors including universities in the vicinity of the small scale business firms and local government officials leads to innovation taking place at a speed fitting the local stakeholders and in areas crucial for further development and competitiveness of the business. For example, in Lake Katwe, where salt has been extracted by manual labour for over 100 years, improvements in quality and work conditions can only be achieved with continuous experiments and dialogue on site with salt workers together with local scientists.

Local, small scale development of natural resources has contributed to economic and social development of rural communities in both the cases presented. Some key success factors seem to be:

- Respect for local knowledge and needs, such as control, deliberative progress and joint decision-making.
- Balance between competition and collaboration within local groups.
- Interdisciplinary research addressing different aspects of the work conditions and products.
- Mutual trust between the stakeholders including government.
- Support from University leadership to establish and pursue Mode 2 type research.
- Gender aware planning to include and embrace women's and men's work conditions and position in society.

- Consideration of environmental situation to address aspects of continued utilization of the natural resources during forthcoming years.

Epilogue

Response-ability and research

Like a winding string passing tryings at risk, this essay collection is my endeavour to make explicit the situatedness and responsibility of research and researchers in the trouble, let it be in the 'grand challenges' of our time or in the very local challenges of survival. The situation demands increasingly open and including systems for knowledge production. Bruno Latour (1998) characterises the situation as follows:

> *All of us have become members of collective experiments on global warming, the influence of genetic engineering, conservation of species, demography, pollution, etc. Thus we have to practice something that, until recently, was the calling of very few specialists, namely science policy. Now everyone is led to practice science policy over a vast range of scientific and technical controversies. This has entirely modified the relations of the public with the producers of science and technology.*

In this incalculability of the late modern spheres of society I place my research and efforts to promote more complex and integrated understandings of 'society in science' or science as a political arena.

Arie Rip (2011) discusses how science and technology can, and should, play a role in meeting the "grand challenges" of society including sustainability, global health and food, water and energy security etc.. He proposes a shift of perspective from priorities in relation to grand challenges and their implementation, to the question what existing and future science and scientific institutions can actually achieve. He argues *while the challenge of institutional capacity building (including receptivity to grand challenges of society) is recognized, actual measures tend to be ad-hoc and superficial……dominant narratives (like the linear model of investing in science and technology to realize innovation to realize economic growth) continue to be more important in shaping what happens than in-depth analysis and diagnosis of what is happening and what future developments of the system could be.*

Elisabeth Gulbrandsen with her many years of experiences from the Norwegian Research Council comments the issues of grand challenges by the questions *what kind of challenge is a grand challenge? And how is the research and innovation system positioned in relation to them? Are the challenges only "out there" in society – or are they 'in here' in our research and innovation systems - as well? This re-thinking is a daunting task – and we have only just begun* (Gulbrandsen 2015).

Within the dynamics of distributed technology and knowledge production in multi-stakeholder contexts including emerging acceptance of the understanding of 'society in science' and not only 'science in society', the issue of responsible research and innovation (RRI) appears. One of the roots

of RRI, which challenges the 'taken for granted' split between science and society, is expressed by Ravetz (1975, p.46) as "Science takes credit for penicillin, while Society takes the blame for the Bomb." Ari Rip (2014) indicates that RRI is a kind of social innovation, ranging from discursive and cultural innovation to institutional and practices innovation. A social innovation, alike a technological innovation, is new, uncertain and distributed. RRI in its start of a more transgressive idea has increasingly been embraced as a concept by many and especially so in the European Commission's Horizon 2020 Program.

In 2013 the first state-of-the-art book about RRI was published titled *Responsible Innovation: Managing the Responsible Emergence of Science and Innovation in Society* (Owen, Bessant & Heintz 2013). In the foreword Jack Stilgoe states that the gap between the global rich and global poor has expanded, while the productivity of science has exponentially increased. With this in mind we cannot hesitate to ask where the responsibilities for unrealized promises and unintended impacts are placed, if science and innovation are allowed to take credit for their productivity.

> *Once we lift the lid on innovation to reveal its politics, we can start to see that, for all of the good intentions of individual researchers, innovation can be a form of what Ulrich Beck calls "organized irresponsibility.* (Stilgoe, 2013 p. xii)

There is no doubt technologies "co-evolve" out of interactions in specific contexts. This implies the responsibility for where and how these technologies travel and with what use, to be a collective one. And once again "responsibility is not synonymous with liability, and innovation looks less and less like a pipeline, if indeed it ever resembled one."

The danger that the term RRI becomes a polite label for the status quo is already visible in EC contexts. In 2015 the Expert Group on Policy Indicators for RRI within the Directorate-General for Research and Innovation published their report[188] on *Indicators for promoting and monitoring Responsible Research and Innovation.* The expert group defines RRI as 'a transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view on the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products'. The group states "RRI has acquired prominence by its status as a 'cross-cutting issue' of the EU framework programme for R & I, Horizon 2020, as well as its central place among the objectives of the 'Science with and for society' program within Horizon 2020". I am looking for signs of the turn to 'society in science' in the document. There are few if any. I register the Expert Group has struggled with opening up a mandate for inviting to processes of learning and development. This indicates resistance experienced by the Expert Group. It is thus reasonable to recognize that the report reflects compromises.

Transformation ambitions expressed in the report does not leave the policy-making context. But if we take Latour's statement above seriously we all increasingly have to consider being located in the policy-making context including researchers and engineers. Although recommendations of the use of the indicators to be taken to embody the principles of good governance, openness and

[188] ISBN 978-92-79-43169-2, ISSN 1831-9424, doi 10.2777/9742

participation through a network approach rather than a linear, top-down chain of command, the performance indicators for the recommended indicator criteria[189] are recognizable from what we have seen before. Within each of the eight indicator criteria, performance indicators are listed, predominantly quantitatively. If we as an example take indicator criteria nr 3, gender equality, 'counting heads' (percentage of women) dominates heavily. I find no signs of RRI gender equality indicators suggested differing from earlier EU research funding programs.

If little or none resistance for RRI occurs, then the chance increases drastically for status quo and no transformation indicated however needed in science. Perhaps it is naive to think of the macro level EU organization to welcome RRI as a transformative intervention challenging all the investments made in the dominant science discourse (of mode 1). Resistance can be recognized, as exemplified above, for the work done by skilful experts to rescue at least the existence of some RRI related initiatives. This is worth learning from.

I keep on leaning to Donna Haraway (1988), who made me aware of the fact that no innocent position exists, and to Jane Flax (1992) and her reminding of 'the end of innocence' in the dominant discourse of western academia.

Helga Nowotny make huge sense to me, particularly when I am with family, friends and colleagues in Tanzania and Uganda, in the following statement.

> *Innovation is the collective bet on a common fragile future and no side, neither science nor society, knows the secret of how to cope with its inherent uncertainties. It has to be done in some sort of alliance and a sense of direction, which is shared.* Helga Nowotny (2005b)

Involution

In a lecture Donna Haraway (2014) brought up the concept / figuration of involutionary momentum. What kind of forward moving potentials lies in this concept? Haraway was referring to an article written by Hustak & Myers (2012). The article gives a fascinating story emerging from the field of chemical ecology and includes a rethinking of Darwin. The authors amplify Darwin's modes of attention and involvement in the daily activities among insects and orchids and found "in his account the nascent contours of an *affective ecology* forming the grounds for a science of interspecies relations". Hustak & Myers supplement evolutionary logics with an *involutionary* mode of attention, the "momentum through which organisms reach toward one another and involve themselves in one another's lives". They are motivated by Haraway (2007) to turn towards attention modes of relationality and "becoming with" while trying to leave the traditional evolutionary trees. It is inspiring to learn how the authors draw together feminist theories of affect[190], difference and

[189] 1.Governance, 2.Public engagement, 3.Gender equality, 4.Science education, 5.Open access/open science, 6.Ethics, 7.Sustainability, 8.Social justice/inclusion.

[190] With their use of affective I find a clear link to Barads understanding of affective, when she discusses 'touching' in measurements in chemistry or in physics (see e.g. Heisenberg's theory of relativity) and points out that "touch engages us in a felt sense of causality, whether we generally acknowledge that or not, and whatever it is we may think of this charged and highly important term. Touch moves and affects what it effects" (Barad, 2012, p. 208).

responsibility as well as rhizomatic thinking by Deleuze & Guattari (1987). In addition they lean on the work of Barbara McClintock and her "feeling" for plants' dynamic lives, which brings me back to chapter 1 in this book. Deleuze & Guattari (1987) writes about 'creative involution', which Hustak & Myers appreciate as an approach strengthening relations constituted through affinity. They cite Deleuze & Guttari in becoming "is not an evolution, at least not an evolution by descent and filiation": it "concerns alliance".

I frequently use words with the prefix 'co-' like co-evolution, co-production, co-operation, co-opetion in my thinking and writing. Maybe it is time to advance into the 'in-' preface and practice tryings to go from co-evolution to in(-)volution. In the lecture mentioned above Haraway was occupied with the use of sym- like in sympoiesis meaning collectively producing systems, which cannot be defined by boundaries. This means that involutionary processes are characterized more by vitally necessary links than separate entities cooperating together. The re-thinking story of affective ecology concerning orchids by Hustak & Myers gives us an example of, even a figuration for involutionary processes, which I find possible to be used elsewhere. Another striking example on involution is the about 2 kilograms of bacteria in the human intestines – a co-existence from which neither we or the bacteria could have evolved (involved) and survived.

I would rather use involution as a concept for the stories I have told from Tanzania and Uganda, stories from contexts of very scare resources and survival, and especially so by referring - in a figurative meaning - to the following statement.

> *If evolutionists tend to fetishize economic logics, random mutations driving generational change, and functionalist accounts of adaptation, involutionists amplify other dimensions of ecological life. They are awake to the fleeting and contingent forms of life happening "now," and "now," and "now." In so doing, they draw attention to practice and to the momentary improvisations of multispecies practitioners caught together in affectively charged ecologies.* (Hustak & Myers, 2012, p. 97)

Involution is to build alliances, affinities and connections and to be aware that we always are in becoming in 'the no longer and not yet'[191].

[191] It is not easy to find the origin of phrase 'the no longer and not yet'. I have learned it from Elisabeth Gulbrandsen.

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