SHARING FRAGILE FUTURE

FEMiNIST TECHNOSCIENCE IN CONTEXTS OF IMPLICATION

LENA TROJER

MAKERERE UNIVERSITY PRESS
KAMPALA

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

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Abstract

Like a winding thread passing through tryings at risk, this book is my endeavour to make explicit the situatedness and responsibility of research and researchers in trouble — whether in the *grand challenges* of our age or in the very local challenges of survival. Efforts to promote more complex and integrated understandings of society in science, or of science as a political arena, are urgent when facing the incalculabilities of our late-modern spheres of society. There is no doubt that technologies co-evolve out of interactions in specific contexts. This implies that responsibility for where and how technologies travel, and for what uses they serve, must be collective. No innocent position exists. The demand on us as producers of knowledge and technology is focused on the reality-producing consequences of our research and thus places us right into the context of implication.

The frames of understanding are developed within feminist technoscience and are linked to practitioners and writers of Mode 2 knowledge production. How can feminist research, and other disciplines that take a critical view of science, mobilise the transformatory potential required?

Part I presents insights into the relocations needed in (onto-)epistemological infrastructures, and Part II outlines a positioning within the fields of feminist research and feminist technoscience. Part III discusses experiences and 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) urges 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 production within a time frame from the middle of the 1980s 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 devoting my academic endeavors 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 come mainly but not solely from my appreciated colleagues 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.

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 father couldn't afford it. No problem, I used my head and a slide rule in plastic.

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

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.

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 who have had a huge influence on my thinking and acting besides highly valued influences from my daily

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.

colleagues in different contexts. Please let me briefly draft the core parts of this frame constituting the thinking floor upon which I walk.

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, world-producing, 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 reflectivity[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 am bringing my positivist unlearning forward by using several epistemologies, where poststructuralist strategies are some of the more useful ones. Poststructuralist strategies as 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 used 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.

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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

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 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.*

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

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 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 technoscientific 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 anymore, 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 puts 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 a broader societal context — has caught my interest as considered in Part IV and which keeps me to the fundamentals 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 truths, theories and methodological approaches are questioned? This challenging ambition doesn'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 a researcher in chemistry.

Clean and Unclean Facts[1] — Diffractions[2] in Knowledge Production

I am a feminist and a researcher. I have received traditional research training in faculties of natural science and technology[3]. 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 received its 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[4] 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 can consist of elements external to science. In

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

2 Haraway, 1997b, p 16.

3 My doctoral thesis, see Trojer (1981)

4 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).

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 prerequisites of each other's existence[5].

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 borders.

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[6]. The impacts of bringing Donna Haraway's idea of *situated knowledge* straight into the world of chemistry and

5 This development also contributes to the use of technoscience as a disciplinary concept.
6 A more detailed discussion will be found in for instance (Keller 1992).

physics with its formula fixation are still a true challenge[7]. 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 humility 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 pays 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 digitalization of systems. I was a postgraduate research student in the

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7 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."

field of analytical chemistry during the second half of the 1970s. My research was concentrated on the development of instrumental techniques, and I worked both within the faculty of technology and the faculty 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

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 manipulative tendencies and lack of honesty among researchers. These problems with quantitative methods bring about serious consequences, which we can observe, for instance, in theories about women's bodily and mental functions based on hormone and brain research[8]. 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

8 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).

uninterested in anomalies and in the knowledge inherent in anomalies" (cited in Keller 1983).

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 relatively 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[9].

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[10]. 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[11] 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[12].

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,

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

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

11 Svenska Dagbladet (The national newspaper Swedish Daily) 1994 04 08

12 Wikipedia retrieved 20160418.

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, 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[13].

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.

13 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).

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 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 closer examine scientific theory formation. My early aim has been to problematize the notion of objectivity from feminist research perspectives 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 into technoscientific contexts and located in transdisciplinary cooperation, is a framework of understanding. This framework is now and then accused of being the result of political pseudo-research. 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 to the surface the political content of all research activities and triggers the sensitivity 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 for many years has included a close cooperation and friendship with my colleague Elisabeth Gulbrandsen and still does. 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 in trying to achieve transformations in our respective daily academic and research policy contexts.

Authority in Transformation[14]

> *... 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.* (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)[15].

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[16]. 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 resources for transformatory projects. This shift represents our "headline" challenge. This chap-

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

15 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?"

16 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!

ter 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[17] holds a science critique programme[18]. 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 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

17 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.

18 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.

"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"[19] 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.

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

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 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[20]. 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"[21]. 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).

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20 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.

21 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).

In spite of such fine ambitions and ideals existing in Norway for more than 50 years[22], 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 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.

22 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.

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[23].

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.

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23 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).

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.

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 1990a, 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 1990a, 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[24], is sanctioned by the ruling apparatus after fulfilling both explicit and implicit conditions. As Smith puts it: "The notion of 'fact' .... indicates a recurrent orderliness of movement from locally ordered observations to the textually mediated discourse ... " (Smith 1990a, 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.

24 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).

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 frequently situated in contexts external to the university. Within the university, I often encounter the esteemed, so-called curiosity-driven research, which is presumed to yield relevant problem-solving applications in the future. The identification of problems based on recognised needs characterised FRN (the Swedish Council for Planning and Coordination of Research[25]). This positioned FRN as a distinctive research council, fostering and advancing expertise in interdisciplinary research and providing support for its practice. My involvement with FRN, both as a board member and through a research policy assignment commissioned by the Swedish government and coordinated by FRN, afforded me significant insights not only into interdisciplinarity but also into transdisciplinarity (as conceptualised by Gibbons and Nowotny). My reference framework, outlined in the introduction and underpinning my scholarly approach, is oriented towards interdisciplinary and transdisciplinary methodologies, which are the focus of this chapter.

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.* (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.* (Nowotny, 2005a)

Interdisciplinary research is widely recognised as being problem-oriented[26]. A project developed on the basis of identifying a research problem — whether originating externally or from within the scientific community — is undertaken by researchers from a range of academic disciplines, which may or may not be closely related. The "span" of interdisciplinarity can vary considerably. There is what may be termed short-span co-operation, involving fields that are relatively closely related, such as the natural sciences, engineering, and medicine. At the other end of the spectrum are wide-span projects that encompass distantly related or unrelated fields, for example, collaboration between the natural sciences and the humanities. In the latter case, a group of individuals convenes, each bringing distinct theoretical and methodological "baggage" in terms of training and onto-epistemological positions. The group is formed with

25 Forskningsrådsnämnden

26 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.

the explicit aim of conducting research into a problem that necessitates perspectives, theories, and methods from more than one discipline to be addressed or to develop knowledge and understanding of it. However, interdisciplinary research may also be conducted by a single scholar with a background in several disciplines, or by a researcher who initially approaches the problem from one discipline and subsequently engages with others. In the latter scenario, the potential for interdisciplinary research to generate new and intertwined theoretical (and even methodological) practices may be even greater than in the former.

One, albeit somewhat trivial, measure of the degree of interdisciplinarity in a project is to analyse the extent to which the results are presented in articles co-authored by the participating researchers. If this is not the case, it may be more appropriate to refer to the project as multidisciplinary rather than interdisciplinary. Indeed, this appears to be the case more often than not, despite the frequent use of the label "interdisciplinary research". I am aware of the considerable effort required not only to realise a genuinely joint interdisciplinary project based on creative and effective collaboration between researchers from diverse scientific backgrounds, but also to ensure that the interdisciplinary work influences the culture of the individual disciplines, for example, through theory development.

When discussing the processes of knowledge production in interdisciplinary research, members of the academy often place significant emphasis on the importance of scientific education within a well-established and distinct discipline. A clearly defined, codified, and legitimate theoretical and methodological foundation is considered necessary for successful interdisciplinary collaboration with partners from other disciplinary traditions. This view is contrasted with that of those seeking to establish systems of education and research based on overarching "themes". The discipline of technology is, by its very constitution, interdisciplinary — it comprises "projects" grounded in knowledge from long-standing and accepted academic traditions, although this is typically interdisciplinarity of the "short-span" variety, for example, between mathematics, physics, chemistry, and computer science.

If the need for interdisciplinary research arises from the recognition that research based on a single discipline is insufficient to address the problem or generate the required knowledge, then fostering interaction between the participating disciplines becomes urgent. The "risk" associated with such interaction is that it may precipitate changes in the theoretical and methodological norms of the individual disciplines. It is well known what kinds of apprehension, prejudice, and protective behaviour such boundary-crossing processes can provoke. If the majority of academics continue to harbour such fears and behaviours, then, at a minimum, there must be a focus on developing epistemological competence in graduate and postgraduate education for the system (discipline) intended to foster interdisciplinary education and knowledge production. In the humanities and social sciences, it may not be necessary to emphasise this competence, as it is already embedded in the curriculum. However, my experience in the natural sciences and engineering leads me to assert that epistemological illiteracy is

widespread in these fields. Using myself as an example, I wish to emphasise that developing interdisciplinary practice is demanding — not only in relation to the interdisciplinary project itself, but also regarding the scientists' own intellectual and scientific prerequisites for such work.

My own and my colleagues' experiences of interdisciplinary work highlight that crossing disciplinary boundaries acts as a catalyst for accessing reservoirs of informal and tacit knowledge. This knowledge is either too self-evident to be noticed or so intimately connected to our sense of self, experience, or disciplinary training that it is not available for reflection and transformation in our routine research activities. Trying interdisciplinary transformations thus becomes both a means and an end, imparting a processual character to my work.

Helga Nowotny (2005a) offers five arguments in favour of interdisciplinary research, which she finds easy to articulate but still challenging to realise. The headings and brief comments on the arguments cited below are situated firmly within the context of the academy, which should be borne in mind when comparing them with her subsequent arguments for transdisciplinarity:

- The world has problems, the university has departments – but how can 'real world' problems be translated into scientifically feasible as well as scientifically attractive research questions?
- The whole is more than the sum of its parts – but how can a timely synthesis of different specialised bodies of knowledge be achieved?
- Knowledge, skills, methods, and instrumentation often transcend disciplinary boundaries – but how can one determine which knowledge, skills, methods, and instrumentation are useful and transferable from one field to another?
- Serendipity and new discoveries often occur at the borders of established research fields and/or disciplines – but if only we knew in advance where this would happen.
- Industrial research demonstrates that it is possible to work in an interdisciplinary manner with positive results – but industry is primarily engaged in development (applying existing knowledge), and universities do not operate in the same way as industry.

A noteworthy position is presented in a significant report from the Academy of Finland, which studied approaches to and the practice of promoting interdisciplinary research at the Academy (Bruun et al. 2005). The report is of particular interest because the authors thoroughly discuss Gibbons' and Nowotny's identification of knowledge production in Mode 1 and Mode 2, dedicating an entire chapter to the rhizome model of scientific knowledge production. This advances the discussion of interdisciplinary and transdisciplinary issues. One general conclusion (p. 59), not specific to the Academy, 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. "There is a clear recognition of the importance of interdisciplinarity, but at the same time a cautious adjustment to the strong disciplinary norms of

the Academy, for instance by stating that "one should be careful not to emphasise the importance of integration too much" (p. 68).

The interdisciplinary question as an epistemological project

My reflections on interdisciplinarity are firmly grounded in my position as a feminist technoscientist. Among feminist researchers, there appears to be a general consensus that feminist research is inherently interdisciplinary. Why is this the case? On what basis is this assertion made? One evident reason for this claim of interdisciplinarity is the manner in which feminist research was introduced into the academy in Sweden. The development of feminist research within universities started at the end of the 1970s. Centres for Women's Studies and Female Researchers, as they were then called, were established at the bigger universities[27]. These centres brought together feminist researchers from diverse disciplines, thereby creating an interdisciplinary environment that had various significant impacts. The Swedish government recognised[28] these centres as independent yet co-operating authorities, with an interdisciplinary focus important for both feminist researchers and female scientists. Many of the activities conducted at these centres pertained to education. The courses they offered were[29], and continue to be, predominantly based on interdisciplinary approaches. For example, in Denmark, the Danish Centres for Women's Studies organised a joint interdisciplinary PhD programme entitled The Meaning of Gender in an Interdisciplinary Perspective. The courses offered in this program addressed epistemology, theory, and methodology, as well as specific subjects. The PhD program was approved by the Research Council of Humanities and the Danish Research Academy as part of the established research education in the country. This was followed by a Nordic Research School in Interdisciplinary Gender Studies, which commenced in 2004. Another example is the consortium and research school on Interdisciplinary Gender Studies, known as InterGender[30], coordinated by Tema Genus at Linköping University, Sweden. The background to this consortium is the Swedish-International Research School in Interdisciplinary Gender Studies, InterGender, funded by the Swedish Research Council with 12.5 million SEK from 2008 to 2014. This research school organised 27 international PhD courses in intersectional gender studies, as well as three international conferences, with a primary focus on PhD students' participation and training.

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

27 See introduction

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

29 more information can be gained at www.genus.gu.se

30 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 among all feminist researchers appears to be an interest in, and practice of, the development of feminist theories alongside methodological considerations. This is, to some extent, a reciprocal interdisciplinary "project"[31].

What we observe here, then, is an interdisciplinary "project" situated at a unique cross-section. It is an epistemological project, and as such, it transcends the boundaries between all disciplines. Feminist research operates in a relatively informal manner and can be applied wherever it is needed. Researchers can select and adapt approaches according to their own preferences and contexts, thereby contributing to its ongoing development by participating in a range of academic and non-academic activities.

Earlier, I stated that interdisciplinary research is commonly recognised as problem-oriented. The feminist research I have encountered within faculties of technology is generally motivated by the identification of a number of serious problem areas, particularly in relation to issues such as information technology and biotechnology, and their multidimensional potential and capacity from global and environmental perspectives. In technology, the complex of problems is more concerned with the production of knowledge about the realities of everyday life than with knowledge production as a basis for creating material and immaterial goods. In order to develop complex understandings and to be an active participant in the production of knowledge, you must be able to "become answerable for what you learn how to see"[32]. This ambition is linked to the view of science as a set of cultural practices, and in this respect, it is necessary to raise accountability both within and about science. Elisabeth Gulbrandsen has explicitly placed the "accountability challenge" 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 work is rapidly being converted into the new growth-industry of environmental management[33] 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, stating (1991, p. 201) "Perhaps our

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

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

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

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 identified problems motivating feminist research is not the creation of interdisciplinary alliances and projects to solve concrete problems as such, but rather the focus on the foundations of the phenomena or factors generating the problem within the complex of knowledge production. This is why the specific cross-section of interdisciplinarity is of an epistemological nature, bringing together feminist researchers from various 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 progress from the conceptual space in which our mutual, interdisciplinary, epistemological "project" is situated, to create a space within everyday life for concrete interdisciplinary work?

Case 1

An experiment was conducted at Luleå University of Technology, where a research department entitled Gender and Technology was established at the beginning of 1994[34]. Over a relatively short period, this theme attracted a group of researchers and doctoral students with markedly diverse disciplinary backgrounds, ranging from human work science, computer science, chemistry, the history of ideas, and medicine, to environmental planning and design—in other words, a highly broad-based research group.

The research projects at the department in the late 1990s were divided into four principal areas:

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

It was essential to identify forms that facilitated the joint development of theory and method. Accordingly, work was initiated in a collaborative research program entitled (Techno)scientific Challenges in Feminist Research, encompassing the following themes:

- Technoscience / the concept of technology
- Feminist research perspectives
- The research complex

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

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

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, which required a profound interest in and concern for "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 specifically located within a technical faculty. It was launched on 1 September 1995 and was scheduled to run for three years. The explicit aim of the Graduate School was to increase the number of female research supervisors, teachers, and managers within the technoscience sector, and 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 research education, one that was effective and able to accommodate the preconditions and needs of each individual research student.

The fifteen 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 more than one year. The recruitment also included the supervisors of the female research students (all male). The research students represented 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, and Business Administration and Social Sciences.

The Graduate School program was incorporated into the study plan for each individual research student and comprised mainly faculty courses, advanced seminars, and various development projects. Successful research supervisors must possess a strong interest in research, education, and leadership, and this was reflected in the program for the Graduate School, which focused in particular on communication, pedagogy, research processes, theory of science, project planning and financing, organisation, personal development, and leadership in research organisations.

Although the Graduate School for Women was not an explicitly interdisciplinary project, its curriculum included competence-building elements vital for interdisciplinary practice. The latter can be characterised by epistemological awareness and reflection, as well as communication competence at multiple levels. The participants in the Graduate School project established a robust network among themselves. All the different meeting situations that developed within this network contributed to increasing the participants' curiosity about each other's research fields, research methodologies, and identification of scientific needs. The colleagues in the Graduate School were also able to meet each other's needs to a certain extent, as this network fostered questions, discussions, and openness. Interdisciplinary collaboration occurred spontaneously — although it arose most readily between individuals with closely related disciplinary backgrounds.

Perhaps the most innovative collaborative constellation was that between the students of the Graduate School and students from Luleå Theatre Academy, which is part of the same university. This collaboration took place in connection with the course on Leadership in Research Organisations. One of the central issues in this course concerned the prerequisites and conditions necessary for creative work and knowledge production from a leadership perspective. The dimension of knowledge in the body as well as in the intellect was also addressed from this interdisciplinary perspective. This coming together of culture and technology yielded a wealth of unforeseen possibilities

Attempted transformations

As noted above, I briefly referred to the "risk" of changes in disciplinary norms that may arise from interdisciplinary research. What are the views of the researcher herself and her colleagues within the host discipline about the disruption and integration of interdisciplinary research outcomes into the disciplinary traditions of the mother subject? Here, we touch upon the fundamental issue of both the possibilities for, and obstacles to, the movement of theoretical and methodological traditions within a single discipline. The creation of new knowledge necessitates the transformation of discourses—an established discourse is, to some extent, replaced or reshaped by a new one. Various forms of inertia and reluctance to foster new discourses can be envisaged. Nevertheless, knowledge production cannot be recognised as research if the evolution of new discourses is inhibited. These new discourses are always negotiated within the research complex[35]. The discourses of interdisciplinarity — the transformed theories

35 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.

and methods that emerge from genuine interdisciplinary engagement—are contentious at multiple levels. They are, not least, the subject of debate in research policy, both nationally and internationally.

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! (*Nowotny, 2006)

The concept of transdisciplinarity occasionally appears in scientific literature. On such occasions, I am both intrigued and eager to know the intentions of the author(s) in employing this term. For me, it immediately evokes an image of epistemological thinking oriented towards addressing the complex challenges of contemporary society and fostering future-oriented competence for transformative research and knowledge production. According to Gibbons et al. (1994), transdisciplinary research is characterised by the final solution typically lying beyond the scope of any single contributing discipline. The authors identify four features of transdisciplinarity[36]:

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

The relevance of employing a concept such as transdisciplinarity becomes apparent when we recognise that knowledge production increasingly occurs within open and distributed systems (see Part IV). A defining characteristic of transdisciplinarity is its capacity to create and maintain its own problem-solving framework, both methodologically and theoretically, within the context of application. Nowotny et al. (2001, p. 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 merely a matter of converging and transcending established disciplines. Rather, it represents an advanced form of collaboration between academia and a heterogeneous group of knowledge producers external to the academy. The constellation of participating actors is specific to each case of problem-solving.

36 Gibbons et al, 1994, p 5.

Platforms for generating transdisciplinary practice

Case 1

One example of fostering transformative competence in an interdisciplinary, or more accurately, transdisciplinary research project is provided by a study concerning water and sanitation technology, which also incorporated strong environmental and feminist research connections[37].

The primary objective was the production of knowledge, focusing on a specific situation in an urban area in South Africa. However, situated knowledge[38] was also developed by certain involved authorities in Sweden. A cornerstone of the project was to explore the advantages of participatory methods[39] and their application in feminist engineering (Rydhagen 2002).

As one of the most crucial prerequisites for survival, water is of pivotal importance in this type 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 improving these conditions is increasingly recognised as a central part of the solution. The disproportionate focus on piped water and sewage systems is concurrently giving way to a variety of in-situ solutions employing simple, low-cost technology. Methods for successful community involvement and low-cost, in-situ solutions for water and sanitation are still under development.

Considerable research has been undertaken concerning the relationship between water, sanitation facilities, and health in low-income countries. Given the complexity of this relationship, it would be naïve to expect a universal explanation for the problem of water-related diseases, and advice on effective disease prevention remains far from unambiguous. Studies indicate that water quantity is at least as important as water quality in determining health standards in individual households. Thus, the time and effort expended on water collection, and the responsibility for this activity, are of great relevance; domestic water and sanitation activities are, of course, highly gender marked.

The aim of this project was to move gender issues from their marginal role within the evaluation process to the centre of technology development and research. During the research process, it became increasingly clear that there is a lack of cross-fertilisation between feminist theory and what is termed "gender awareness" in development work and assessments. Feminist theories can often be rather abstract, discussing hierarchical relations in society in general terms. Development workers engaged in concrete projects, on the other hand, refer to gender roles in specific situations without drawing connections to broader sociopolitical and cultural structures. Although gender is fre-

37 The presentation of the project is based on a research project accomplished by Birgitta Rydhagen.

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

39 The participatory research method used is called PRA (Participatory Rural Appraisal) and is described in Chambers (1997).

quently mentioned in connection with water and sanitation projects, the issue of how exactly gender awareness is intended to influence the projects themselves is seldom discussed in depth. Feminist research is rarely incorporated at any stage of technology development as a source of knowledge and expertise.

The research goal of the project was to explore how gender and feminist theory, as well as gender awareness, can inform sanitary engineering in a manner that benefits as broad a segment of society as possible. By posing the engineering question within feminism, this project sought to move "gender" from the evaluation process into the very locus of technology development. This is regarded as a highly urgent step, as it is becoming increasingly apparent that the diffusion of technologies can be considered successful while simultaneously having very detrimental consequences for people and the environment. The location of feminist research in a technical context is relatively rare, and this project was an important element in the attempt to foster inter- and transdisciplinary feminist and technology research praxis.

With this type of study, other agents enter the research process — both in the form of individuals directly involved in local technology development (PRA) and through the introduction of new theoretical perspectives (feminist theories, rather than simply gender as a variable). This, in turn, necessitates discussion and reassessment of the traditional academic mindset. By traditional academic mindset, I do not refer to a literal evaluation of our scholarly traditions, but rather to the types of appraisals performed in the everyday processes of the academy—in teaching, discussions with colleagues, seminars and conferences, or in peer review situations (evaluation of articles, books, theses, appointments, and grant applications). The experiences gained from both the research itself and the discussions constitute a foundation, upon which the kind of research-transforming competence necessary for creating the new discourses we need, can be developed.

Case 2

With the recognition of academic praxis in a transdisciplinary context — that is, daily work as researchers and teachers in a distributed system of knowledge processes — I wish to highlight the research division of Technoscience Studies at a Swedish profile university focusing on applied ICT, Blekinge Institute of Technology (BTH).

The main academic aim of Technoscience Studies was 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 associated processes of transformation and knowledge production. Viewing ICT as reality-producing technology rests on the idea that all of us, including researchers in the field, are enmeshed in development processes, where an innocent position does not exist. Information technology intervenes in and shapes people's everyday lives. Conversely, information technology is developed and interpreted by people. The work of Technoscience Studies aimed to create both a theoretical basis and 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 materials 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 the present era, knowledge is generated in the overlapping borderlands of universities, companies, and other regional, national, and international actors. These processes were particularly evident in the region of Blekinge and influenced the manner in which BTH conducted 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 boundaries between science, technology, politics, and society, and between humans and non-humans, as well as the processes of hybridisation between people and machines (cyborg theories), etc.

This transdisciplinary trying of Technoscience Studies[40], which commenced in 1998 with support from the Swedish Government, became the foundation for undergraduate education in media technology. By 2019, its PhD program had awarded twenty doctoral degrees.

Ontology of resistance

Although the results presented above may be—at least temporarily—satisfactory for the development of an academic space for transdisciplinarity, and even for feminist transdisciplinary environments, there are hard-earned experiences regarding the conditions that must be fulfilled. One important condition is the presence of research political signals and support at the national level, which is further elaborated upon in Part III. Earmarked funding, whether from government or other authorities, for these local transformative initiatives within a traditionally rigid institution such as the academy, means you don't have to put all your energy in fighting for resources at the decision-making boards of your university. Instead, efforts can be directed towards building alliances with constructive forces both within and outside the university, which always exist to some extent.

The condition I wish to discuss is the willingness, strength, patience, and understanding required to encounter the various forms of resistance that invariably arise in transformation processes (Ahrenfelt 2001). My colleague Peter Ekdahl has substantial experience in this area and, in his doctoral thesis (Ekdahl 2005), has written about resistance within a faculty of technology when establishing media technology as an inter- and transdisciplinary academic field for graduate and postgraduate education.

On the website of ACT Lab (Advanced Communication Technology Lab, University of Texas), where Sandy Stone has been active, the following could read[41]:

40 www2.bth.se/tks/teknovet.nsf/

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

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 draws on Bo Ahrenfelt to discuss transformation processes and the resistance that follows in their wake. Ahrenfelt emphasises the need for what he terms a *second-order transformation*, thereby inverting established models for organisational change. The organisational transformation to which he refers 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 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 interprets the two quotations above as considering transformations as attempts to disrupt prevailing patterns of thought and action, and thus as a matter of changing the prerequisites of the system. The impact implies that the view of self-understanding, of humanity, and of life is called into question. This, in turn, affects the values within the system and its interactions with other systems. Accordingly, transformations of a second order cannot be predicted in advance. Predictions exist only in transformations of a first order, where the fundamental values remain unchanged. The first-order system does not address the altered demands in the forms of needs and relationships in our own and future times. It is therefore unsurprising that one must face resistance in the academic organisation, and often quite strong and unpleasant forms of it.

The final example for reflecting upon the ontology of resistance is a research political one. The Swedish Council for Planning and Coordination of Research (FRN) was the research funding authority with a mission to support and foster interdisciplinary research, commencing its activities in 1977. FRN also managed research on issues of vital importance to society, identified either by the Swedish Government or by the Council itself—issues to which no other research funding authority paid attention. FRN was a strong supporter of Swedish universities with substantial ambitions to conduct interdisciplinary research and to develop academic competences for the same. It also had a special mandate from the Government to support feminist research.

The mono-disciplinary oriented research councils never acknowledged the importance and relevance of FRN. During a turbulent period in research politics in the latter half of the 1990s[42], strong (mono-disciplinary) academic forces succeeded in persuading the Government to discontinue FRN. Sweden thus reverted to a research political situation reminiscent of the 1950s. This represented a significant setback for interdisciplinarity and the nascent support for transdisciplinarity. The transformation initiatives undertaken by FRN to address contemporary demands for knowledge production encountered resistance at the very core of the system.

42 see chapter 7

Chapter 4

To gain a deeper understanding of the epistemological infrastructures employed within a technical faculty, I draw upon the example of the university at which I have served as Deputy Dean of the Faculty of Technology and as Head of Research at the departmental level. This chapter briefly outlines how feminist technoscience can serve as a resource for research-transformative processes that consciously seek to be answerable when society speaks back. The discussion contributes to debates regarding the necessity of epistemological pluralism within technical faculties and the relevance of feminist technoscience in this context.

Interventions in Epistemological Infrastructures[43]

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[44].

Rationale

At technical faculties, we must engage with complex realities in our research and pertinent address our partners in both the private and public sectors. We must also consider young people and their preferences in the learning processes of higher ICT-related education. The challenges in this context require transformation in more advanced ways than previously anticipated or realised within our academic organisation, which is characterised by longstanding norms of stability and epistemological traditions. A fundamental condition for the necessary transformation is to foster and embrace epistemological pluralism.

Ina Wagner offers significant insights. She argues (Wagner 1994) that the central idea of combining established forms of scientific inquiry with a social pragmatics of deve-

43 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.

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

loping goals, methods, theories, and products can be realised through epistemological pluralism and partial translations between the situated knowledges of different communities.

It cannot be emphasised enough that fostering epistemological pluralism is a challenge at any technical faculty, regardless of its age. Once we have learned to articulate the concept of epistemology, and have acknowledged that our research and teaching are conducted upon a particular epistemological infrastructure, it becomes imperative to question whether this infrastructure is sufficiently relevant and appropriate for our specific needs. My local need is based on the following.

Situated at a technical university[45] with an explicit profile in applied ICT and ambitions for close cooperation between the university, business sector, and government (local, regional, and/or national), the challenges regarding epistemological openness for university staff are huge.

Current knowledge and technology production take place in contexts far removed from those identified with the traditional, Mode 1 (Gibbons et al. 1994) university. An overly closed and unreflected epistemological basis constitutes an obstacle to daily work, whether in research or in educating students at both basic and advanced levels. That is why I am concerned.

Situated within distributed knowledge production systems

There is a widespread recognition in international feminist research, that the production of knowledge and technology occurs within distributed systems. This understanding is closely associated with the dominant technical fields of our era — information technology, biotechnology, and material technoligy. My colleagues and I at BTH, Campus Karlshamn, have been deeply engaged in the complex development of a distributed knowledge and technology production system known as NetPort[46] (Henningsson & Trojer, 2005). This has constituted one of my most significant learning environments for trying transformations in the context of distributed knowledge processes.

The establishment of a new campus resulted from negotiations between the university leadership and the local government of Karlshamn, the intended location of the campus. Simultaneously, the innovation node or system, NetPort, was founded. NetPort subsequently became an organisation co-owned by the university, the local government, and the business sector, focusing on three selected areas. The development of both the campus and NetPort commenced in the year 2000.

Developing a new campus for a university of technology within a Triple Helix context requires at least four initial conditions:

1. Undergraduate students
2. Postgraduate students
3. Epistemological recognition of Mode 2 knowledge production
4. Tolerance towards resistance, which invariably arises in development processes, particularly internally.

45 www.bth.se

46 www.netport.se 2013 NetPort changed name to NetPort Science Park.

In 2000, the Vice-Chancellor of BTH (who later became Director General of VINNOVA — the Swedish Governmental Agency for Innovation Systems — and subsequently Vice-Chancellor of Lund University) authorised the research division of ICT and Gender Research[47] at BTH to assume primary responsibility for developing the new campus. This initiative was supported by BTH through the appointment of a central project coordinator. The division possessed the expertise to launch bachelor's programmes in media technology and was already running a doctoral programme with several PhD students. The division's staff were highly motivated to engage in practical Triple Helix collaboration.

For his approval, the Vice-Chancellor had been convinced of the fulfilment of conditions 1 and 2 above. Condition 3 characterised the Vice-Chancellor's own practice and appeared self-evident to him. The division's commitment to fulfilling condition 3 was likely implicitly acknowledged by the Vice-Chancellor, as explicit interest was demonstrated in collaboration with stakeholders external to the university, with the local government of the campus city being the principal partner.

Regarding condition 4, the division greatly benefited from insights into various forms of resistance, informed by the experience of Bo Ahrenfelt (2001). Peter Ekdahl (2005) emphasises that resistance in development and transformation processes is both significant and generative, even though it may be experienced as destructive and draining in the short term. Without resistance, the ability to focus and direct development efforts is hindered. The sectors exhibiting the strongest resistance are often those most in need of transformation. Furthermore, resistance serves to specify and clarify the terms and conditions necessary for development and transformation, thereby fostering dialogue.

Mutual understandings

How can the situation of academic work in co-evolving processes with society be understood?

If our aim is to produce knowledge that meets the needs of society and is sufficiently robust for sustainable purposes, then we must be rigorous in our understanding of our knowledge-producing systems. Socially robust knowledge can only be generated in a mixed environment, where it is subjected to more intensive testing across various contexts. Such knowledge is not predetermined but remains open to renegotiation (Nowotny et al. 2001). Furthermore, the site of problem identification shifts from the academy to the agora[48], where science encounters society and contextualisation takes place. We are confronted with processes of a non-linear nature. This is far removed from traditional perceptions of sequential processes, where knowledge is first created through basic research, followed by applied research, dissemination, and ultimately the exploitation of knowledge in products for private or public markets. Nowotny et al. (2003, p. 191) articulated this issue clearly in

47 The name of the division was later on changed to Division of Technoscience Studies.

48 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).

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 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 the reference literature is that science and society are subject to the same driving forces in

- the pervasiveness of a new economic rationality
- the transformation of time and space (not the least as effects of ICT)
- demands for self-organising capacity
- the generation of uncertainties and risks[49].

These processes can be described as science and society becoming transgressive, encouraging society to respond to science. Jasanoff (2003, p. 225) addresses the impetus for society to respond, 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" is the issue of the input of resources and the output of results. In the linear way of thinking about science and society, we tend to focus on the input of resources, whether these come from government, public or private funding agencies, and so on. 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 is becoming increasingly evident that "society speaks back" by requiring participation not only in the input phase but throughout the entire process (which is more likely to be non-linear) up to the output of results. In the context of NetPort and at the municipal level, we have observed how society, represented by the local government, explicitly demonstrates the need and commitment to being involved in the entire input–operation–output process[50].

This engagement arises from the mutual "project" of fostering sustainable development within the local and regional community. The prerequisite for this 'project' is a triple helix-like process (Etzkowitz & Leydesdorff 1997), which in our case was sustained by ongoing dialogue. In this dialogue, which resembles an agora, mutual understandings

49 Beck 1992.

50 See chapter 11.

began to find expression in very concrete ways, and a co-evolving process takes place. For those of us who have been involved, we refer to 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"*[51]. (Gulbrandsen, 2004, p.120)

By briefly presenting the situated knowledges I have encountered within a distributed knowledge production system, I hope to clarify my argument for epistemological pluralism as essential for the transformation needed in technical faculties. Below, I will elaborate on why and how feminist technoscience can serve as a resource for developing epistemological pluralism and, consequently, innovation systems.

Feminist technoscience as a resource

The feminist research undertaken within engineering sciences at technical faculties has increasingly focused on fundamental epistemological issues and the development of theories and methodologies. The pertinent questions of boundaries, and the transgression of boundaries between science, technology, politics, and society, necessitate terminology such as technoscience. Donna Haraway is among the leading scholars advancing a complex understanding and practice of this terminology. When considering boundaries, we must remember that boundaries "do not sit still" (Barad 2003, p. 817), underscoring the complexity of our realities.

A defining feature of feminist technoscience is its research transformative ambitions. In many respects, this forms an obvious foundation. From an international perspective, we are dealing with an increasingly radical project of transformation (Trojer 2000). It is insufficient for a researcher merely to discover and map a pre-existing reality "out there"—that is, to remain within the context of discovery. Research must also address the context of application as well as the 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 emphasised in technoscientific reflections. Haraway (1991, p. 196) asserts that what we can reasonably achieve in our knowledge production can never be more than partial translations. Translations are always interpretative, critical, and partial. These constitute the very condition for being heard when we claim rational, relevant knowledge. Rational knowledge is founded within a process of ongoing critical interpretation among multiple interpreters. Rational knowledge includes power-sensitive conversations. The world and its phenomena, Haraway states, neither speak for themselves nor disappear in favour of any particular chosen interpreter or master decoder. The codes of the world do not simply wait in silence to be read.

51 See Argyris (1991) and Nowotny et al (2001).

We may ask ourselves why these kinds of research activities are so deeply involved in the development of a distributed knowledge production system such as NetPort, and why they are among the driving forces in these development processes. The answer lies in certain identified potentials and experiences of this research (Rydhagen, Trojer 2003; Björkman, Elovaara, Trojer 2005), namely to:

- expand the knowledge frameworks 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 the relationships between research, the political sector, and industry
- create driving forces for inter- and transdisciplinary constellations.

Building epistemological infrastructures

I recognise the necessity for co-evolving processes within the core activities of our technical university. Relevance and situated knowledges are key elements in our efforts to foster the epistemological pluralism required. We observe a transformation in situated knowledge production in our context, shifting from a focus on contract negotiation and input towards an emphasis on co-evolution and the entire chain (input–operation–output). There is a clear increase in the demand for universities and other stakeholders to demonstrate their relevance in order to be accepted as partners in contemporary ICT knowledge development. From the university's perspective, this demand does not render academic knowledge production less motivating, of lower quality, or a less desirable occupation; on the contrary, it enhances its value.

What challenges do we face in the near future as academics and feminist technoscientists at technical faculties, and as collaborators in NetPort? The foremost challenge is the added value that core activities must develop at local, national, and international levels. This necessitates intensified cooperation between the main Triple Helix actors — university, local government, and the private/public sector. We must advance further in the process of trilateral arrangements, sometimes even assuming the role of the other when necessary, and join efforts to achieve added, unique value. Our engagement in generating epistemological pluralism that is sufficiently relevant and appropriate for our specific needs is a significant asset. This requires us to continually develop our understanding and practice of transformation, reality production (world-making), relevance, and situated knowledges.

Karen Barad operates within interconnected epistemological fields and fosters 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 wish to highlight the concept of intra-activity. Barad refers to intra-activity as a reworking of the traditional notion of causality. She seeks alternatives to representationalism[52] 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", bringing to the forefront issues of ontology, materiality, and agency. 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.

52 Compare the contexts of production and implication (Nowotny et al. 2001).

PART II
Feminist TechnoScience — trying a position

I use the concept "feminist research" interchangeably with "gender research", and use "feminist technoscience" almost synonymously with feminist research within the domains of technology and engineering.

Within my academic context, I am still required to justify my identification as a feminist researcher. When I began my career in the 1980s, I believed it would be possible to "cleanse" the concept of the feminist researcher from the various misconceptions and associations that people tended to make (Wahl 1996). This concept remains provocative (in Sweden), as it is perceived as "political"[1] and as a transformative agent within an academic discourse that is often resistant to change. I should interpret this situation positively, as it signals a transformation of a second order (Ahrenfelt 2001), which is precisely what I am striving for.

The feminist technoscience I advocate is not only analytical and theoretical, but also engages in practice, seeking to act as a transformative agent by "staying with the trouble" (Haraway 2010).

1 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 intended to justify a comprehensive and fair presentation of feminist research, if that is even possible. Feminist research is far too widely spread an academic field to be condensed into part of a chapter. I write about how I have encountered and understood feminist research along the paths I have walked so far, and how I position myself within feminist research.

Feminist Research

A Statement

Feminist research is a distinct scientific area of expertise with an international academic tradition spanning 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[2]. 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 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 sciences 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 the 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.

2 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 to which 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, which had been in use in the Anglo–American research communities, had too strong an ideological bias for Swedish tastes. This term now seems to exist in a parallel universe alongside more strategically viable terms. The term könsteoretisk forskning (gender theoretical 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 gain a firm foothold[3]. 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, 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 absolutely 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.

3 See also Hirdman (1998).

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)

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 the natural sciences as it emerged in the 1980s and 1990s. The critique began with questions regarding the differing working conditions of female and male researchers, then progressed to expose biased and distorted research based on gender, and ultimately led to a more fundamental questioning of the very processes of knowledge used in the natural sciences. I draw extensively from Sandra Harding's (1986, 1987a,b) work on the development of a feminist theory of science within the natural sciences and technology.

In the 1980s, typical questions included: 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? Are the laws of natural science not absolute, objective truths that humanity discovers, sooner or later? Feminist theories of knowledge sought to demonstrate 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, the natural sciences – and that all knowledge production is contextually anchored.

It is a matter of a feminist perspective and critique of the history, ideological foundations, and knowledge production of the natural sciences – a feminist epistemology. Internationally, this epistemology within the natural sciences is very young. Feminist analysis and theory within other fields, such as psychology, sociology, history, literature, and so on, 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 the invention of printing, available through Christine de Pizan[4].

Focusing on the Nordic countries, feminist critique of science within the natural sciences has existed for roughly the same length of time as elsewhere, but it has mostly taken place outside traditional institutions. In the Nordic countries, this critique has been presented at seminars and conferences, in gender studies journals within the individual Nordic countries, and in anthologies and reports (Rose 1992, Ullerstam & Vramming 1992). Feminist critique within the natural sciences 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 acted 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 influence the development of knowledge without the inconvenience of public control.

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

In the 1980s, Sandra Harding, Professor of Philosophy at the University of Delaware, compiled a feminist epistemology based on biology and sociology. This combination and approach largely coincided with the development of a feminist critique of the natural sciences in the Nordic countries. I had struggled with her publications. I knew there were important things for me and for us, just starting with feminist research in our mother disciplines. But it was not until I met Sandra Harding in person in the Finnish forest (see introduction) that I truly understood her. She summarises the development of feminist critique and theory thus (Harding 1986):

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

It is the first two elements that primarily affected the natural sciences and engineering. However, this does not mean there have not been interesting analytical tools within postmodernism and poststructuralism, contributing to 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 undertaken, both within natural science and elsewhere.

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

I. Renowned 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, by focusing on exceptional women, the contributions made by less well-known female researchers remained invisible.

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

III. Research into women as victims (sometimes referred to as "misery research"), for example issues of power relations and the exclusion of women from academia.

All three areas have been important in the early developmental phase. They drew attention to the conditions in which female researchers worked and the consequences these 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 men remain 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 resulted in exclusion[5]. She came from Uppsala and lived from 1875

5 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).

to 1968. Astrid Cleve was the first woman in Sweden to obtain a doctorate (1898) in natural science and the third woman to obtain 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 period 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 among the first to emphasise growth physiology and biochemical aspects. Her academic background was in biology and chemistry. She was the eldest daughter of the renowned chemistry professor in Uppsala, P.T. Cleve.

Most of her life she was forced to conduct 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 established theories in Quaternary geology, but which became valid areas of research. Her views are being afforded ever more value.

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

Feminist empiricism

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

Feminist empiricism emerged from liberal feminism and asserts 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 using only male animals (this also applies to humans) and yet still drawing conclusions for the whole species. One of the arguments for this practice is that females' hormone cycles disrupt the findings.

The normal values used in medicine are often based on values from men, for example, young men undertaking military service. This has led to women receiving incorrect treatment, for example in connection with high blood pressure and heart attacks. Much of the vast amount of research that has been done on the brain since the beginning of the 1900s has sought and claimed to have found physiological differences between men's and women's brains (Sayers 1982, Walsh 1979). These studies have

provided biological arguments for the supposed inferiority of women. Ruth Bleier, a neurological researcher, has shown how substandard studies and biased interpretations of results have 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 question 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 problematised; rather, it is assumed that it is capable of eliminating all prejudices and distortions arising from the fact that individual researchers have different backgrounds, nationalities and 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 it does not question scientific logic and its methods. However, 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 questioning of the fundamental values and consequences of science. For this purpose, feminist empiricism is inadequate as an analytical model and epistemological approach. This is where feminist standpoint theory takes over.

Sandra Harding introduced this theory and made it widely known. It was then primarily developed by the Canadian sociologist Dorothy Smith (1987, 1990b). Dorothy Smith presented her standpoint ideas more as a method of thinking than as a finished theory. This analytical model uses a standpoint which begins 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 is ideologically 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 distorted 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 that feminism and women's movements develop theories and motivation for research and political reform able to transform women's perspectives into 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 on which to build our theories. Harding claims feminism makes 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 becomes 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 particular 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 fundamental development of natural science.

Alternative to the Master-Slave dialectic

As the feminist critique of science emerged and created explanatory models, a need also arose 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 the reduction of as much knowledge as possible to a few simple, generally applicable laws (see 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 determined. This dogma is, according to Keller, a typical example of a master theory, which Barbara McClintock opposed ever since it was first deve-

loped 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 midst 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 – natural science encountering the challenges of planet's 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 employ universal claims and demands (Barrett 1992). It criticises the feminism of the 1970s, which developed universal demands of this kind. The debate seen in postmodernism is part of a broader criticism of contemporary thought systems with their universal characteristics.

Postmodernism includes a critique of rationalism as a doctrine and the impacts it has had on the human subject and different forms of subjectivity. It involves 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 relinquish 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 in

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-related interests are expressed, which intersect 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 suppresses poetic language, which reveals 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 interpreted by Witt Brattström, 1984)

The linguistic turn in feminist research was later 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 be followed in a strict time scale but to be experienced in parallel. Making partial translations into the context of technology has made sense and constituted a platform to envision 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 1990s 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[6] 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) communicate in a polylogue, a polyphony of non-hierarchical voices. We produce knowledge in a network of discourses without a centre, I would say, using the

6 Journal for Metafysisk Spekulasjon (for metaphysical speculation)

work of Dorthe Gert Simonsen in her paper about poststructuralist strategies from 1996. Simonsen comments on 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 adds 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 being 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 legitimising knowledge by universalising. 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."

Chapter 6

Developing feminist technoscience within technically oriented disciplines is a collective endeavour. For me, the day-to-day reality of this work has involved collaboration with PhD students, undergraduates, research and teaching colleagues, and staff in a variety of roles. Without them there would be no feminist technoscience in practice. In this chapter I may be read as harsh towards academic communities that focus solely on studies, even though I greatly appreciate much of the work carried out within these spheres. I want the feminist technoscience I advocate to operate in real-world contexts as well as to contribute to the academic field of technoscience.

Feminist TechnoScience

Within faculties of technology

The history of feminist technoscience located within faculties of technology and engineering has moved from the practice of counting heads (how many women) towards fostering and advancing understandings and practices of knowledge production. This is not a linear progression but rather a set of parallel processes. Gender-equality work continues and remains far from achieving its goal of a sustainable 40/60 per cent representation at all levels. The academic narrative in Sweden over more than three decades shows we have shifted from the gender-equality question, via the woman question[7], to the science question. This refers to the Harding turn (Harding 1991), which shifts the emphasis from what science can do for women to what feminists can do for science. There are no simple or automatic links between these broad phases.

Over these decades we have consistently 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 advanced 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 sufficient to conduct gender research on technology from the 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 continue to value 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 quotation was displayed on the wall of the lunchroom at a research laboratory focusing on water-jet technologies near BTH. Together with a colleague, we were engaged to integrate a gender-research perspective into an EU project at that laboratory. The Haraway quotation was initially difficult for the water-jet researchers to comprehend in our introductory discussions. However, some of them took the initiative to copy it and put it on the wall in the

7 e.g. developing cars or speech synthesizer suitable for bodies of women

lunchroom for further internal debate. Almost a year later, when we returned for continued collaboration, we found the researchers appreciating the quotation and the discussions it had stimulated.

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 Technoscience is a concept frequently used by Donna Haraway. She argues that, despite the hype, technoscience as an overarching theme is not the greatest story ever told; "it is playing powerfully to large, widely distributed audiences" (Haraway 1997b, p 4). She also emphasises 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 (Gulbrandsen et al. 2006) emphasises, a reverse logic: knowledge often has to be applied in order to be tested. A classic example is reproductive technologies[8]. In feminist technoscience, the political discussion about the relation between research and politics—i.e. the reality-producing aspect of science and research-is therefore vital.

Engineering science is characterised by classification, standardisation and formalisation within a framework of general consensus. Bowker and Star (1999, pp. 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 particularly concerned with studying this foundation and developing new approaches to the core of knowledge production, in order to strengthen science's capacity to effect change. This research has made an impact by demonstrating the kinds of understandings of knowledge, science and technology that dominate and that have consequences in terms of creating realities. Internationally, feminist technoscience provides an epistemological infrastructure for a range of choices and decisions in societies increasingly dependent on research and technology. This research is therefore no longer simply about drawing attention to the perspectives, experiences and needs of women.

Within the tradition of feminist technoscience developed in Sweden and internationally, theoretical growth represents a complex and extensive knowledge process of an interdisciplinary and transdisciplinary character. This means my academic working environment comprises not only research colleagues from a variety of more established disciplines, but also researchers developing epistemological competence for the inter- and transdisciplinary research they pursue, as well as other knowledge producers outside the academy.

8 from in-vitro fertilization to cloning see e.g. www.finrrage.org

Outside versus within

For many years, studies adopting a gender perspective across numerous fields (sociology, economics, history, pedagogy, labour organisation, to name but a few) that have made technology their object of research have attracted attention. What distinguishes this research is that women, gender and gender–power relations are the focus, rather than the formation of technoscientific knowledge itself. This research is therefore marked by an outsider perspective in relation to technology and lies outside the bounds of gender research conducted within technoscience.

The field of science and technology studies (STS) is an example from the social sciences and humanities where technology, natural science and the relations among technology, natural science and society constitute the "study object". It is notable that feminist STS has existed throughout the development of the STS field. STS is a central research area that helps identify problems—for example, how traditional gender stereotypes colour the way we think and act, including our relationship with technoscience and its products. Nevertheless, there is still a long way to go before this research stands at the forefront of concrete technological development. Although feminist science and technology studies (feminist STS) has been, and remains, 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 created for technoscientific gender research at technical faculties from recruiting researchers with very divergent disciplinary backgrounds. In addition to civil engineers and technologists, there are many humanists and social scientists. Together these researchers form viable, productive interdisciplinary groups.

The research focus

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

What probably distinguishes feminist research within technoscience from other feminist research is that it moves beyond the study of gender fairly quickly. Advanced technical research on, for example, the development of speech-synthesis systems for women treated for throat cancer is not primarily a subject of gender research. Such work has been a low-priority area within normal science (which has tended to focus on developing speech synthesis for men). This kind of work is often called 'addition research', where researchers simply add the category 'women' to existing research. In medicine, addition research has prompted contentious negotiations between established research paradigms and gender-focused approaches, and between different orientations within medical gender research.

A radical transformation project

A common trait of feminist research is the ambition to transform research. In many ways this is an obvious starting point. From the outset, deficiencies and distortions in established research motivated feminist researchers. Thus, new feminist research comprises a critique of science. From an international perspective, we are dealing with an increasingly radical[9] reform project (Trojer 2000).

The research-reforming work of feminist technoscientific gender research rests on certain fundamental starting points. For example, it is not enough for a researcher merely to discover and chart an existing reality that was waiting "out there" to be found (the context of discovery) (see Chapter 4). Research must also address what Elisabeth Gulbrandsen calls the context of production. 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 as researchers, then, 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 address demands for theoretical and methodological openness, which Ina Wagner (1994) formulates in methodological principles, namely:

- 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.

Radical transformation processes require visions of a preferred future. It is extremely difficult to escape fixed mindsets and envisage what that future might be. One helpful tool is to use figurations; one of the most profound in feminist technoscience, offered by Donna Haraway, is the cyborg. Haraway explained (in Markussen, Olesen, Lykke 2000, pp. 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 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.*

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

Agent of change

If the research of technology and researchers' positions is being renegotiated and relocated, the self-critical question is: can feminist technoscientific research be a reliable agent of change in arenas where alliances are neither given nor secured, but where, on the contrary, no sympathies or successes can be guaranteed? Donna Haraway's (2003, p. 7) answer is simple yet difficult:

> *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 asserts that the epistemological, methodological and empirical fields of practice are not owned by a group of academics with the privilege of being solely entitled to define goals or means. Disparate experiences, skills and stories meet. Patience and labour are required for something new to emerge from the asymmetries. What unites all the actors is a desire for a sustainable future, which can only be created in association with others. In Donna Haraway's (1991) words: "…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 also scholars such as Sheila Jasanoff, Sharon Traweek, and Elisabeth Gulbrandsen, present compelling arguments regarding research as a reality-producing or world-producing activity. Science is (co-)creating society and is, therefore, inherently political. For this reason, I emphasise that researchers must also engage with the political dimensions of their work. As a scientist, I must recognise myself as a producer of realities, both for myself and for others within society. If this assertion appears overly abstract, consider the roles of medical or ICT researchers. Researchers who explicitly adhere to Mode 1[1] often find this perspective provocative, as it challenges the dominant epistemology of neutrality and objectivity, and rejects the so-called *God trick*[2] (Haraway 1991, p. 189).

Wendy Hollway (1989) asserts that science, as we know it, could only become dominant because it was preferred; and being preferred necessarily entails strong involvement in political matters.

Before delving further into these co-constructions of research and politics, the following three chapters address a rather unique research policy situation in Sweden, specifically concerning support for interdisciplinary and feminist research.

1 Gibbons et al 1994

2 "God-trick of seeing everything from nowhere"

Chapter 7

During the 1990s a window for specific research politics opened, which acknowledged the social relevance of research and embraced a more inclusive approach. This benefited not only interdisciplinary research but also feminist research, and in addition a regional distribution of academic institutions across Sweden. This chapter concerns research-political developments during the 1990s. A number of research bills have been submitted since those of the 1990s, but none has shown the kind of explicit link between research and politics presented in this chapter.

Diffractions in Research Political Tendencies[3]

> *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 post-modern research organisations (Smith, Webster 1997). I shall 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 shall 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. However, first

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

3 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.

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, post-structuralist streams of understanding). Hence my choice of terms. The vision of purity and orthodoxy is the distinguishing feature 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 knowledge production 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 continuing 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[4].

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 problem formulation, participation, transparency throughout the entire research chain

4 Dnr 1999-0843:2

and active mechanisms for knowledge transfer. It also establishes 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 forms of collaboration for research support and 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. This applies to our technical and organisational infrastructures, for example within communication, energy supply, the food industry and also to more abstract systems such as the way our daily experience of events is shaped by the media. In many cases, complexity is related to potential vulnerability and risk. Developing an 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 attended a research conference in Denmark in 2000[5], 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 beyond traditional borders. The 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" (that is, increasingly dependent on research and technology), how are we to understand

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

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 formerly marginalised groups (read women and immigrants) to participate in power definitions and preferential interpretations, and the simultaneous restructuring of the institutions? More specifically, what should we think of the potential differences that integration of these groups into the institutions and knowledge production would generate?

By way of summary, we can see that late-modern social change has challenged the organisational constraints and principles of 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 become subjects of debate at both cultural and institutional levels. Western universities have become mass institutions and their authority has been questioned. In these shifting circumstances, we must ask what will constitute the stamp of approval for knowledge production in the future and how the institutional structures will be organised. How are we to understand the processes of change, and what visions can be developed when the future institutions of higher education face 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 nanotechnology. 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'[6] (also known as 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

6 Official Norwegian Report NOU 1991:24

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[7].

> *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)

Bertel Ståhle describes the situation thus in a Swedish Government Official Report[8] on the research-policy landscape in the Nordic countries in the 1990s. The Official Report forms part of the research funding report[9], that was led by Susanne Eberstein and was one of the starting points for the research bill Research and society[10].

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

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

8 1996:28

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

10 Prop. 1996/97:5

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 approach, 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 programmes was recognised. 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, programme 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 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[11] 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.

Landberg 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 shall not 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[12]. 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[13] 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 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.

11 Forskningspolitik [Research policy] SOU 198:28
12 Prop. 1992/93:170
13 Prop. 1992/93:171

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[14]. 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.

14 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.
8. The links between education and research must be strengthened.
9. All universities and colleges will be allowed to administer their own research resources.
10. Swedish research shall contribute to international research and actively collaborate with research in other countries.
11. 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[15] 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[16], which the minister Thomas Östros presented in March 2000. This bill came as a response to the turbulent situation in the research-funding system in the second half of the 1990s, which had serious repercussions throughout the entire research community. The bill entailed a compromise. The old, discipline-oriented knowledge production was given its 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

15 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.

16 Prop. 1999/2000:81

majority. We could see a tendency towards adjustment to more present knowledge and research processes in the merger of the research councils for natural science and engineering science. Sectoral research continued and was reorganised by topic into two research councils and one agency – the Research Council for Work and Social Issues, the Research Council for Environment, Agricultural Sciences and Spatial Planning and VINNOVA (the Swedish Governmental Agency for Innovation Systems).

The bill proposed that continued negotiations between research and politics, between science and society, be given a 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 discuss openly overriding research-policy issues that were not the concern of a single funding 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, and so on. It was suggested that the board should 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 were situated 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[17]. 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 was an excellent method for unveiling truths. Indeed, it would be a good thing if the whole of society worked like a higher seminar.

17 Liedman 1997

However, this straightforward image of research does not apply to the other two research councils 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 meeting societal needs, which goes far beyond the commercial requirements of our globalised, market-driven society.

Research policy and a college specialising in applied IT

Östros' research bill discussed IT research, stating that research related to information technology was 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 (for example, informatics, media and communication and aesthetics). The government deemed that the largest joint effort in the IT area was being conducted within the framework of the R&D programme for which NUTEK (the Swedish Agency for Economic and Regional Growth) was responsible. 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 Sweden's current lead regarding the development and application of modern information technology in production processes and service design. The government also believed it was important to pursue 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 programme for 2000 emphasised research and education to be useful to society, which is 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[18] 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 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 and so on. 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[19]).

The backlash

As mentioned in the beginning of this chapter a number of research bills have been submitted since these of the 1990s, but none of them has shown the kind of explicit link between research and politics as the one of 1996/97 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 1990s 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.

18 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.

19 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 focus on the turbulent research-political period in Sweden during the 1990s and on feminist research politics. Since the 1990s, the system for research funding has changed. The separate research councils for 'basic' research were merged in 2001 into a single Swedish Research Council (VR), at the same time as the Swedish Council for Planning and Coordination of Research (FRN) was closed. I present some situated experiences, mostly connected to the actor explicitly charged with feminist research, namely FRN. To help reduce collective amnesia concerning feminist research politics, I discuss in some detail a Swedish Government Official Report (SOU) from the 1990s.

When gender is on the agenda[20]

Research Political Comments

Thanks to the efforts of a number of prime movers within the field, Swedish research politics in the 1990s increasingly put gender on the agenda. Prior discussions had focused on quantitative aspects of equality, such as how to increase the number of female researchers in technology and the natural sciences, as well as the number of women in higher positions within university hierarchies, 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 is better to examine the complicated and interrelated aspects of the making of technopolitics in the late-modern research complex. To foster feminist research in this situation, frameworks for understanding characterised by transparency, context-sensitivity and a motivation to meet relevant societal challenges 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 prominent among the issues addressed by research politics. However, in Sweden a number of professorships in feminist research exist in fields such as history, sociology, economics, medicine and technology, which are intertwined with research-political issues. These chairs have been suggested by the Ministry of Education and approved by Parliament. In the Swedish context this has meant earmarked financial resources allocated to the universities at which these chairs are located.

Most academic research in Sweden is performed at universities. In contrast to neighbouring countries, very few autonomous research institutes exist in Sweden. Parliament decides on allocation of basic (faculty) resources in the budget bill. These resources do not guarantee full salaries for research and higher education staff. External financing is necessary for research projects and programmes, which constitute a comprehensive

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

part of the economic base for PhD students and academic staff[21]. 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. To obtain the benefits 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[22], strategic research was given high priority, with the main focus of investment 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.

From 1991 until 2001, the Swedish Council for Planning and Coordination of Research (FRN) was responsible for supporting 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 FRN — feminist research located both within traditional academic disciplines and in newer inter/transdisciplinary fields of study. FRN's central role in the promotion of feminist research was an important phase in the creation of a financial base for this kind of research and its consequences. However, FRN's central role also contributed to a lack of responsibility on the part of discipline-based research councils and other research-funding authorities for the increasing interest in feminist research projects. There are, of course, exceptions that prove 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 research funding system to support and develop the research politics of feminist research[23]. FRN was organised 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 equal-opportunities research projects. The committee did not give priority to any field in particular; the most obvious reason for this was that very few other research-funding authorities had shown any interest in supporting feminist research. However, one of the last calls from FRN encouraged

21 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%.

22 Research for Knowledge and Progress, Prop. 1992/93:170.

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

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

It is possible to identify the location of feminist research politics within FRN, which coincided with the research-political role FRN had been given and had taken on. FRN, as an interdisciplinary and even transdisciplinary research council, took 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 university researchers; the interest was already overwhelming. Instead, FRN's task became to find methods for handling the large number of proposals, to treat the evaluation process as a particularly pressing problem on the one hand, and 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 FRN's detailed budget request, which was to be incorporated in the research bill and the budget bill to Parliament. This method was not very successful. The second strategy was to change priorities in FRN's total budget in favour of feminist research. This had already been done (see above). The resources needed for feminist research alone, however, would take up most of FRN's total budget. It would not be reasonable to give such heavy priority to feminist research, given the other important programmes of FRN. Other solutions had to be found. One promising solution appeared to be the active integration of feminist research into all other programme committees of FRN. I will return to this strategy below.

A fourth strategy for increasing resources was to co-fund projects with other research councils. There was no reason why this form of research funding should not become 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-funding of feminist research projects was not a feasible strategy.

A fifth strategy would be for FRN to pursue research-political initiatives, also via the Ministry of Education, to influence other research councils and sector research authorities to assume responsibility for financing feminist research within their particular fields. The government's research bill presented to Parliament in 1996 was surprisingly clear about this point (see below and 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[24] — 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[25]. The suggestion was not considered in the 1996 research bill and no separate feminist research council has yet been proposed by the government.

The establishment of evaluation processes within feminist research — i.e. the selection of competent scientists who can judge project proposals — has proved 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 permit judgements 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. Another complicating factor is that feminist research is located both in established disciplines and in new inter/transdisciplinary fields of study. We will not get relevant judgements when, for instance, a sociologist evaluates feminist technoscience. This may seem an obvious point, but it is not always the case within 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 eased if feminist research were more firmly integrated into the different research councils, and if alternative criteria for evaluation were established (Gulbrandsen 1995c).

24 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).

25 For a further discussion see below.

Technopolitical questions in feminist research

In the discussion above I have tried to steer away from the quantitative goals of equal-opportunities issues, towards identifying prerequisites for the involvement of feminist research in technoscientific matters, and further to the present questions of research politics as part of technopolitical movements. I would like to dwell briefly on the processes that evolved within FRN, largely because of the central role it played in research politics concerning feminist research. If there was any single place where one might find signs of a shift in feminist research politics, it was within FRN. Accordingly, it was within FRN that we could identify new technopolitical tendencies by looking at the choices and changes in programme committees and the priorities given to activities within these committees.

In one of the last detailed budget requests[26], which was thereafter to be included in the research bill every third year, it was notable that information technology gained a stronger position, in addition to the, from a research-political view, interesting field of Science Studies[27]. At the same time discussions about the location and aim/role of feminist research were taking place. In FRN's budget request it was suggested that the committee for feminist research and equal-opportunities research should remain within FRN's framework, but change its name to the committee for feminist research. Another idea discussed was that feminist research, wherever possible, should be integrated into the other programme committees within FRN. The Committee of Technology and Society was in the process of being merged with the Committee for Research on Library and Information Science. Within this amalgamated committee, information technology was given greater priority. The programme 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.*[28]

According to my interpretation of this programme, it constituted a breakthrough in the technopolitical question of feminist research. The theoretical and methodological 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 committee's programme 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

26 FAF for Swedish Council for Planning and Coordination of Research 1997 – 1999.
27 In the FAF it is called 'Research about research'.
28 As it appeared in the text of the call for application 1997.

apointments in the field[29]. This happened during the spring of 1996. Having collected suggestions from all the universities in Sweden, in an attempt to solve problems of organising the analysis work, in which both the committee for 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[30], the final proposal was delivered to the government to be incorporated into the research bill. FRN's suggestion was to create one new professorship and to provide resources for one research assistant and one doctoral 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 that 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 — perhaps even stronger — among feminist researchers. Complex chains of events began when different interests were given 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 does one balance the interest of one's 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 represent a possibility of intervention for the field of feminist research. The potential for intervention in technopolitics depended upon where the chair was located — either in traditional fields of consequence studies or integrated into transformation processes in a technoscientific context.

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.

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29 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.

30 Presented in FRN-nytt (FRN news) nr 2 1996.

Official report as feminist research politics

The former Minister for Equality and Deputy Prime Minister Mona Sahlin set up an official investigation with the dual aim of finding measures to promote 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[31] 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. The criticism of the official report, both from feminist researchers and from male researchers in the established academic system, requires more detailed presentation and analysis than is given here. I will concentrate on the parts concerning technology.

In the report the field of technology was commented upon with statistics on resources allocated to women and female staff at universities and by different authorities. The discussion centred primarily on the representation of women. Apart from the comments made by the investigators, technology was treated in my contributing text "The technoscience challenges in feminism". A variety of voices from female emeritus professors, female students and 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 was that feminist research was rendered almost invisible within the field of technology[32].

It is obvious that technopolitical interest in the investigation's proposals was minimal. Perhaps we should not be surprised, considering the aims and directions characteristic of contemporary feminist research in Sweden and the phases this research has undergone. One reason for this is the dominant position the social sciences occupy in feminist research in Sweden and elsewhere, for understandable reasons. However, this dominance offers only limited 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 large extent and legitimately, is involved in "mapping" projects, which have not proved to yield the transformational potential we hoped for. This focus draws attention away from the work of problematising the foundations of technoscience, which is a prerequisite for the involvement of feminist research in technopolitics in relevant, interesting and transformative ways. I am aware that the feminist research I want to see developed demands sensitivity within the research complex and that this is difficult to justify. It demands great courage from the researcher who sticks their neck out. I believe in and place great value on strong inter- and transdisciplinary connections in research praxis. This cannot be overemphasised in efforts to bring about the changes discussed.

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31 in Swedish 'kvinnovetenskaplig', yet another term for what I have called feminist research.
32 SOU 1995:110, pp. 173.

In the investigation, as well as in Swedish feminist research politics, a double strategy is proposed. Feminist research remains a bait not easily swallowed, leading to the need for both an autonomous and an integrated position. The investigation moved the centre of gravity towards the autonomous position in its proposal for the establishment of a centralised feminist research authority and a research council exclusively for feminist research. The impact on feminist technoscience is easy to imagine — the inevitable engagement with technopolitical issues and the technoscience question would be made extremely complicated, if not impossible. Moreover, the argument for demanding responsibility from 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 council of their own, but should compete for and demand their legitimate position from the funding authority to which each individual project belongs. If we do not proceed in this way, we will find ourselves quarrelling about scraps while others handle the billions. Besides, we would make it difficult to have influence beyond the confines of our own project — that is, to make gender irrelevant as an epistemological factor[33].

A Research Bill to Parliament Supporting Feminist Research

The most feminist-friendly research bill to Parliament[34] so far was presented on 18 September 1996. Interesting differences can be noted compared with the earlier bill, which was dominated by the establishment of research foundations. The earlier bill began with detailed reflections on the role of cultural 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 — the "more women in" kind. There was no problematisation of the dominant norms in the production of knowledge except perhaps for the creation of a new professorship in gender and technology.

So what happened in the 1996 bill I interpret it as a kind of breakthrough. For the first time, we had a research-political document that consistently distinguished between feminist research[35] 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.*[36]

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

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

34 Research and society, Prop. 1996/97:5.

35 The concept used in the present bill is now gender research compared to women research used in the former bill (see note 3). Feminist research is still too strong and charged a concept to use in a research bill in Sweden.

36 Prop. 1996/97:5, pp. 55.

The introductory parts of the bill also repay close reading. We find here, in my view, 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 occasional 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"*[37].

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"*[38].

I want to highlight one strategically important proposal in the bill 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[39] among the existing research councils[40]. The instructions for the united action group focused on 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"[41]. A careful, ambitious and resolute handling of these opportunities would have had the potential to create a basis for opening up all research councils to 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

37 Ibid. pp. 54.
38 Ibid. pp. 101.
39 In Swedish Samverkansgruppen
40 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.
41 Prop. 1996/97:5, pp. 207.

chairs were potentially in the field of technoscience and natural science (information technology, the didactics 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*[42].

Frames of evaluation

When gender is on the agenda, it becomes increasingly 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[43]. When technopolitics is located within a context of research politics, the frameworks of evaluation do not become less important or less complex. In feminist research there is potential to promote transparency in the decision-making stages of the evaluation process.

Among the first things to stress is the political content of technoscience[44]. I am not referring only to the consequences and political implications of technology, but to the political content of the whole research process. When I transpose this consideration to the humanities, I risk stating the obvious. If I, by contrast, bring up this discussion in a technical and natural-scientific context, I commit almost a crime against the still dominant belief in the neutrality of knowledge. The deep involvement of research activities in a political context is often 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 they 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 implicated 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.*

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42 Budget Bill to Parliament for the year 1997, Prop. 1996/1997:1.

43 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).

44 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.

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 contribution to the discussion can be found in the international project about the production of knowledge, supported by 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.*
>
> *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 opportunities for feminist research that opened up in the Swedish research-political system in the mid-1990s created a great deal of hope and expectation. We know the processes that need to be started in order to transform possibilities — the words formulated on paper — into available, located resources are highly complex, not straightforward, and demand considerable work and problematisation.

We find ourselves in a peculiar situation of parallel processes. We are engaged in learning processes at the same time as we are trying to carry out research integration. On the one hand we must learn about relevant integration strategies; valuable knowledge and experience can be drawn from interdisciplinary research, where obstacles similar to those facing feminist research exist. On the other hand, coincident with these learning processes, we must implement the integration into the research funding system. At what point will expectations and concrete results converge — both in the short term and in a longer-term perspective? How can our expectations and hopes be turned into resources for the ongoing transformative work?

Chapter 9

As mentioned in Chapter 8, a special window was opened for feminist research policy at national level during the years 1997 to 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 briefly present some experiences from the work of the Committee for Cooperation[45] 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 Bills of 1997 and 1998 were very clear on the importance of integrating feminist research perspectives into the disciplines and giving 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:

- 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)

45 In the Swedish the name is Samverkansgruppen.

- 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 research. 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, cannot 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 in late 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 1990s and beginning of 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[46].

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 foci 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.
- 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

46 The report can be found as a pdf at https://doi.org/10.5281/zenodo.18441511

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 levels 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 1990s. The institutional strength of the Swedish Secretariat for Gender Research[47], 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 in 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.

47 www.genus.gu.se

Chapter 10

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

Scientific excellence has become the catchword of research politics, manifesting itself in the establishment of centres of excellence across Europe as well as in the European Research Council. What is the meaning of this phenomenon? What will we find when we try to open up the black box of "scientific excellence"? The need to question evaluation processes may seem intrusive when we realise the increasing demands on knowledge production to be societally robust, not 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 amalgamates a number of interrelated issues that support 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[48]

Introduction

The article "Authority in Transformation"[49] that Elisabeth and I produced in the mid-1990s 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 remark that we at the time "censured" into a footnote, we put forward an understanding implying that we "in here" have developed something valuable that we want to give to you "out 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 desire to export our knowledge to Indian rural women by asking, "Who appointed you God?" As we find that it is still the scent of "technologies of hubris" and not "technologies of humility" — as figured by Sheila Jasanoff (2003) — that leads us to mark something as excellent research, we find it appropriate to continue writing the same article. Here we copy and paste the second paragraph from "Authority in Transformation".

48 This chapter is a slightly revised text from Gulbrandsen & Trojer (2010).
49 See chapter 2.

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 learning. Being involved in more horizontal partnerships for learning and development remains quite challenging for expert systems in general, and perhaps especially so for academia, which must 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 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)msociety"[50].

Co-evolutionary approaches

At this day and age — following mounting environmental and poverty crises — there is far more unease about presenting research as the solution than in the mid-1990s. The weft of science increases in everything that surrounds us, and at the same time it is possible to ask: what is progress today, and how should it be measured?[51] 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). These features prompted Ulrich Beck to 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 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 clear-cut 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;

50 "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).

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

it is becoming a policy sector in its own right. It is in the fields of technoscience (information and communication technology, bio- and gene technologies, and materials 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 the 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 role in the "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 speaks of 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 perspective can provide our transformatory efforts with better tools to process changes in the relationship between research and society or science and politics, and to produce more substantial, complex and integrated understandings and images of this relationship. By exploring other figurations such as Mode 2, the agora, post-normal science and technoscience as transdiscursive terms, we might 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 predispose political decision-makers and researchers alike to apply technocratic and pseudo-scientific 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 echoes Haraway's situated knowledges (1988) and Jasanoff's technologies of humility (2003). Rather than seeking mastery and control, we should focus on collaboration with the ambition 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[52].

The regime of collective experimentation

Even if the call for such a 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) articulates this challenge. How can we identify potentials, design instruments, promote, manage and evaluate productive interactions between "science and society", or between science, technology and

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

the market? The report collects examples that feature the recent shift from the idea of centralised organisation 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 a range of suggestive figures from the history of science policy such as mandated science, strategic science, triple helix, Mode 2, post-normal science and the 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 among other key players. How come?

Figurations that associate co-production of science and society indicate that such intimate interaction 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 Practitioner: How Professionals Think in Action (1983). This argument may still be felt to be provoking 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? Developing a role as co-player seems dependent on a mode of humility and an acknowledgement of the limits inherent in singular positionalities, which can be hard to find (Jasanoff, 2003; Felt, 2007). It might even be felt to be counterintuitive for researchers to move away from a "mastery and control" mode in order to ask for help and to open up to input from, and collaboration with, others.

Citizen scientists

Helga Nowotny, a 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 needs 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; 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 developing the dialogue between research and society. Here the 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[53]. 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 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 meta-knowledge" (pp. 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 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 by 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:

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53 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.

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 marker 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[54] 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 and is being developed by a network involving several policy organisations[55]. 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

54 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".

55 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.

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, which mainly emphasises 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 that 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 various stakeholders. This is 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 to make explicit and to put into play. The ERiC network underlines the importance of paying attention not only to the inputs in research (people, money, apparatus) and its outputs (publications and other products), but also to the "throughput". By this they mean the processes that mediate with the environment, for example co-operation and strategic alliances. This implies discussions about the strategic positioning of a research programme, thus giving deliberation about goals and public methods weight. Taken together, these principles form a programme that combines some of the lessons of classical pragmatism (notably the anti-dualism) and new governance policy techniques; especially the mechanisms for co-ordination and co-operation, which share a focus on "learning processes" (Spaapen et al., 2007, p. 29). We include a "conclusion" that they arrive at 28 pages later:

> *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 scientists 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 the natural sciences, 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 – epitomised 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 – 167)

The issue of stimulating and developing conflicting and contested perspectives is also part of what Arie Rip (2003) finds 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 aforementioned 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 is also made 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 the 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 scarce resources the quality issues in STI become explicit and easy to understand in, for example, research linked to income-generating activities and solutions addressing fundamental needs for people and society such as energy, food, water and communication possibilities. The robustness can be recognised 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, for example, proofs of concept to be piloted[56].

Government and science as key players amongst other key players

Co-evolution in a non-European context — for example, in East Africa — makes sense in a very explicit way where the mission of national universities and governments coincides 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 of how governments, whether local, regional or national, see the relevance and join in co-evolution processes[57].

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 and societal implications of new and emerging technologies). In the second phase of ELSI research — being developed in the 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, the UK as well as the Nordic countries have put much effort into inviting "society" to speak back to "science", experimenting with different types of stakeholder involvement in order to establish the much-sought two-way dialogues and the productive interactions between science and society. The re-thinking of stakeholder involvement that we see, for example, in the EC and the UK points out how the infamous "deficit model" is simultaneously laid to rest and resurrected in these experiments. They point towards a lesson: 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",

56 For an elaborated discussion see "Normative machineries at work" in chapter IV (Felt 2009)
57 For further discussions see Part IV.

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 and assessed as a vital marker of scientific excellence.

Re-thinking excellence

This chapter aims 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 on the basis of existing normative machineries at work in the academic world. The question is: what kind of quality in academic knowledge production is relevant in which context and for what purpose? Both researchers and policy-makers must 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 crucial skill here is how to navigate a more or less totalitarian political system while at the same time keeping the university as autonomous as possible through learning alliances between scientists and citizens, official and local experts.

We discuss transformation processes — which we recognise and try to take part in — as processes of Mode 2 and transdisciplinarity. Ulrike Felt explores the changing academic research environments in a European context and how researchers encounter, transform and oppose these changes. Felt emphasises the issue of creating and inhabiting what she calls epistemic living spaces (Felt 2009). We recognise these discussions as an important prerequisite for ourselves and other inhabitants of the academic world in order to feel "intellectually and socially 'at home' " (Felt 2009, p. 231) and for "becoming answerable for what we learn to see" (Haraway 1991).

PART IV
Contexts of Implication

My academic focus and great interest in epistemological infrastructures have constantly been 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[1] 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[2] 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[3]. I am constantly learning.

1 I use the concept 'low-income countries' synonymously with the more frequently used concept 'developing countries.´ I prefer to use low-income countries.

2 Information and Communication Technology

3 htpps://www.sicd.se

Chapter 11

How will the understandings and practices of the knowledge production I discuss in this book appear in low-income countries? For sure context sensitivity is essential. There is no time for the Western linear model, in which university resources, however scarce, must be utilised immediately rather than deferred. In this chapter I outline some aspects on why and how university initiatives that adopt alternative models — such as Mode 2 knowledge production, inclusive innovation and cluster development — are relevant and important and have a proven 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'. 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, demands that are more urgent than, for example, in Europe. This means that the 'voice of society' in science argues for use of the very limited public resources in ways benefitting people as soon as possible, if not immediately. Society speaks back in demanding relevant knowledge for survival and better living conditions. This is a strong incentive for finding other ways than the dominant linear approach to disseminating R&D results, which often takes too long and is not always efficient or contextually relevant.

The increasingly acknowledged non-linear knowledge production processes stress the importance for us to assess the unknown, unspecified, uncontrollable and irregular in both research and political spheres. What follows for all actors is to admit that there are knowledge limits in research. Sheila Jasanoff emphasises 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 Western-hemisphere universities. It is a concept rooted in a linear paradigm — knowledge and technologies are produced at universities and research institutions, transferred with or without

IPRs[4] to society with political approval if legislation or the political agenda requires, 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 include frequently weak relevance to societal needs, lack of efficiency, low level of trust amongst societal actors, increased gaps between different groups in society, and weak capacity for evolving innovations and innovation systems.

In Sweden the technical transfer paradigm has been characterised by weak context sensitivity and faith in universal solutions. Technical transfer in the linear mode from a Swedish situation to contexts in low-income countries, such as sub-Saharan regions, includes few success stories. These experiences might be one of several reasons why Swedish aid activities have moved from concrete practice to abstract policy during the last five decades (Kjellqvist 2013). Technical "transfer" in a non-linear mode — more akin to technical co-development between actors in high- and low-income countries — calls for approaches of "polycentric, interactive and multi-actor 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 yet universities are amongst the most stable institutions in societies regardless of political situation. In Western societies and elsewhere, those who pay the bill for universities are governments — that is, taxpayers. The voices of the latter are increasing in strength, or as Nowotny et al. already highlighted (2001):

> *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 required — and requiring — to take part not only in the input phase but in the whole process (which is more likely to be non-linear) up to the output and outcomes of results.

I have experienced at a municipal level in a Swedish context how society, represented by the local government, explicitly manifested the need to be involved, or at least to have insight into, the whole input-operation-output process. The need for this involvement arises from the budgetary process in local government to have local tax resources approved for research funding and infrastructure requests from 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".

4 Intellectual Property Rights

Since taxpayers, via the government, are paying for universities, the primacy of identifying the problems to be solved by research and higher education can no longer remain primarily in the hands of science alone. The loud university voice of "curiosity-driven", free research is losing listeners, especially 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 (at any level). But the Triple Helix concept does not provide 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), in which 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 include, for example, context of application, transdisciplinarity, much greater diversity of sites of knowledge production, highly reflexive processes, 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 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 between basic and applied research. But as Gibbons explained, Mode 2 knowledge production has always existed, and Mode 1 is a very efficient specialisation of knowledge production. This specialisation finds its roots in the scientific revolution of 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 crystallisation. A research team at KTH (Royal Institute of Technology, Stockholm) is working on salt crystallisation processes at different international sites. In one of their projects they used Katwe Salt Lake in Uganda as a case. They did not collaborate closely with the salt extractors at the lake. They took water samples from the lake and brought them home for studies at their laboratories at KTH. Their main priority was basic, disciplinary (Mode 1) research on crystallisation frequencies of the salt. The results of their research

show the salt crystallising in sequences/fractions, where the sulphur-containing fraction crystallises 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 recrystallisation this refinement step to remove more of the sulphur-containing salt is a great achievement compared to the existing local situation. In order to produce so-called table salt for human consumption, the sulphur needs to be removed, as the added iodine chemically bonds to sulphur and thus cannot be absorbed by humans. A low-tech method can be used to detect the sulphur fraction and when the crystallisation is about to move over to the wanted chloride fraction. The researchers suggested that the differences could be tasted with the tongue. This example[5] 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) emphasised that knowledge is accepted or approved not on the grounds of claims to higher scientific authority but through negotiation. This stems from the need for knowledge to be open and sensitive to many interfaces, where contemporary knowledge is created in heterogeneous contexts. In our professional and daily lives, we must make choices only to face further choices, which are not merely technical but encompass uncertainties for which we must account and take responsibility.

In East African countries such as 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) stated 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 relevance is public service and equitable, sustainable socio-economic development. Public needs thus extend beyond purely commercial markets.

This became clear 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 outreach to society and identified needs. The outreach facilities included technical transfer units at UDSM, a substantial amount of consultancy, and the innovation and cluster programmes (ISCP-Tz) supported by Sida[6], starting in 2004. Consultancy by UDSM research staff reflects the fact that much of the expertise needed by firms and organisations was (and is) concentrated at UDSM. Other factors include UDSM allowing a percentage of working hours for consultancy to supplement

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

6 Swedish International Development Cooperation Agency

the very low state salaries in a context of scarce resources. The National Strategy for Growth and Reduction of Poverty (MKUKUTA[7]) provided the basis and framework for the audit mentioned and, at present, for UDSM's outreach functions. MKUKUTA forms part of Tanzania's efforts to deliver on its national Vision 2025[8] and, since 2005, has focused on growth and poverty reduction; improved quality of life and social well-being; and governance and accountability.

It is interesting to note that Economic Report on Africa 2013[9] 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 Parliament in 2003. The Swedish Government reports to Parliament on the PGU biennially. In 2007 the Swedish Government (Conservative at that time) presented a more specific policy for Africa[10], in which it emphasised 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.*

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 the 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[11] responsible among other issues for capacity building of universities in the collaborating

7 www.imf.org/external/pubs/ft/scr/2011/cr1117.pdf
8 http://www.tzonline.org/pdf/theTanzaniadevelopmentvision.pdf
9 http://www.uneca.org/publications/economic-report-africa-2013
10 Skr. 2007/08:67 Sweden and Africa – a policy for common challenges and possibilities.
11 Department for Research Cooperation

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 particularly in closely following SAREC support to the technical faculties in East Africa — Tanzania, Uganda and Mozambique. It was in this context that I became involved in SAREC's support for programmes to develop innovation systems and clusters (ISCP), starting in 2003[12]. When proposals for these programmes were up for decision at the board, I expected hard discussion and resistance from my colleagues because of their inter- and transdisciplinary character, as well as the proposals' radical break with the traditional linear paradigm for the use of research results. However, the decisions went through smoothly with very little discussion. I believe the reason was the well-prepared, substantial and precise decision documents formulated by specific, skilled and experienced SAREC staff members. The strategy was to take decisions step by step instead of launching a single, large programme planned from the outset. This strategy had both pros and cons. On the positive side, the concept of innovation — which was new in a Sida context at the time — had time to find its form. The stepwise strategy also made it possible to handle uncertainties in a programme that was new in kind and initiated processes not yet established in practice in East Africa. The downside was a lack of necessary flexibility while waiting for new decisions, even as programme processes accelerated. It later turned out that the reorganisation of Sida, with the closure of SAREC and the loss of skilled SAREC staff, was disastrous for the ISCP. However, the foundations for the programme in East Africa and, from 2008, also in Bolivia were in place and sufficiently robust, while Sida funding was integrated with fewer resources in bilateral research agreements (for Uganda and Bolivia) and in a specific arrangement with the Swedish Embassy in Mozambique. Rwanda later joined the innovation support initiative at the University of Rwanda because of specific circumstances.

Dissolving the linear paradigm

As indicated above, the linear model of diffusion and use of research results is being questioned and is transforming into other procedures within emerging collaborating universities or developmental universities (Arocena & Sutz 2011). A different university culture is needed to deliver more immediate benefit to society, particularly in contexts with limited resources. This brings us back to the issue of 'a new kind of more mature partnership', which Helga Nowotny (2005c) emphasised when she argued that "science can no longer expect unconditional support on the part of society for whatever it wants to do, nor unconditional acceptance of its authority".

12 For details see http://sicd.se/?page_id=2

It appears easier to dissolve the linear paradigm in low-income countries, where the public good is a matter of survival rather than the commercial benefit of the few.

To move beyond the linear model of knowledge production — and of innovation development and evolution — it is not enough merely to link academic research with the private sector and industry. It requires at least three key players — university, industry and government — which constitute the Triple Helix model presented above. To address innovation issues I draw on the general understanding of the Triple Helix model from the Triple Helix Research Group[13].

> *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 converge and develop shared understandings and roles in always complex contexts and circumstances. This is a significant step forward in the process of dissolving the linear paradigm, but it is not sufficient. As mentioned earlier, the Triple Helix model does not by itself mean that actors know how to work together and develop the integrating processes, which brings us back to Mode 2.

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 within Triple Helix contexts.

Cluster and Innovation System

In the Sida-supported cluster development projects in East Africa and Bolivia, cluster initiatives are used. A cluster initiative may be initiated by government, academia, or a private-sector development agency. Innovation-driven actors from different sectors aim to support renewal and the competitiveness of industry, firms and farms. A decisive factor for the development of a cluster initiative (CI) is cluster facilitation, which

13 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 www.triplehelixconference.org/the-triple-helix-concept.html 2011

supports 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 — often small and micro-enterprises in East African clusters. The CI comprises all the companies and organisations that are linked together — in collaboration and competition — in value creation. The CI is the conscious attempt to mobilise and organise actors and resources to make individual companies in the cluster more innovative and competitive.

An integrating process occurs in successful cluster initiatives. The roles of actors become increasingly clear and the integration of different support systems evolves. Integration also leads to an emerging innovation system that includes actors at local, regional and/or national levels. These parallel processes can be experienced in Uganda at the local level (see chapters 14 and 15) and at the national level. In the latter case, the results of the Innovation System and Cluster Programme (ISCP-Uganda) motivated the President of Uganda to support the cluster programme for five years from July 2010. The resources originated from the national government budget. This situation is relatively unique for university programmes supported in addition by foreign aid. The resources were allocated by the Ministry of Trade, Industry and Cooperatives under a memorandum of understanding with Makerere University, where the cluster secretariat was located. A national steering committee for the cluster programme includes representatives from triple-helix actors. The Ugandan context, however, entails a number of challenges such as weak or absent institutions and financial systems. In spite of this, the Uganda example constitutes conditions for an emerging innovation system needed for a more sustainable situation of socio-economic development.

The experience above provides an example of how "society speaks back" in a constructive way. It is only when concrete and tangible results are demonstrated to local and national government that they become willing to invest. The cluster programme, with a comparatively small amount of support from Sida, thus constitutes a successful activity giving relevance to government and society.

Robust knowledge

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

If a resource vital to cluster firms is found to be profitable, there is a strong likelihood that more powerful external actors will see opportunities to exploit, buy land or property, introduce high-tech methods or engage in business in ways that do not benefit the local economy and the cluster members. Situations are also such that, when cluster firms become more profitable, the risk increases for external interests to manipulate cluster members and take over. This can be observed in both 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.

Robust knowledge for socio-economic sustainability and development depends on context sensitivity. There are numerous examples of genuine context sensitivity and knowledge amongst participating researchers and students from East Africa and Bolivia in the cluster programmes that have now existed for more than ten years. The learning processes born from context-specific knowledge are vital for results that people can rely on and build their futures upon.

Chapter 12

There is a story to be told about how ICT entered Tanzania. The national university in Dar es Salaam (UDSM) was a key actor[14]. It is also a story about an emerging innovation system for ICT. The time window is the years just after the turn of the millennium. 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 innovation processes. A university never stands still, at least not when it comes to organisational structures. CoET later changed form into more than one college. In this chapter we refer to CoET as it existed in the first decade of the second millennium.

ICT and ITS Emerging Innovation System in Tanzania[15]

Questions to be addressed

- 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 questions aim to build understanding of 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 nationally situated ICT development and implementation. The discussion addresses the emerging implosion of postcolonial situations and ICT development.

Academic ICT and its applications in society and everyday life draw our attention to the relationships among dominant actors, one of which is the university. This highlights not only the development of innovation systems but also the need for relevant knowledge about their prerequisites, resulting in transformational challenges for traditional universities. The model explored for these processes is the triple helix model, which states that the three institutional spheres — university, industry and government — increasingly work together and co-evolve[16].

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

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

16 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 practice of postcolonial ICT emerges, and the challenges for the academy and its technical faculties increase. Relevance appears to be the multi-stemmed core concept, and the shift in position from mere transfer to co-development is in strong demand.

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

We can realise ICT as one of the technological science fields most clearly provoking the boundaries between academic research and the political sector (Gulbrandsen 2000), and we can 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 through processes that emerged in a Tanzanian context. It is a translation of situated knowledge at a specific time — the experiences and understandings of Tanzanians engaged in national ICT work in Dar es Salaam in 2003 — including professionals at the University of Dar es Salaam (UDSM), the Civil Service Department of the President's Office, Tanzania Telecommunications Company Ltd (TTCL) and the Tanzania Commission for Science and Technology (COSTECH). The comments are also based on my 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 had a national information and communication technologies policy[17]. The process of working out this policy began at the start of 2000, with an informal group sharing an interest in and a vision for ICT to be successfully applied to 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, drawing on the eThinkTank's inputs and Sida's funding. The ICT Task Force had 15 members and was chaired by the Vice-Chancellor of the University of Dar es Salaam (UDSM), Professor Luhanga. The ICT policy process was open, in order to gather as many inputs as possible from people with very different interests and perspectives. Drafts were circulated to the Government, Members of Parliament, the private sector, academics and other stakeholders, and even beyond Tanzania. Drafts were also posted on webpages for comment. The process incorporated regional and local political levels

17 The document can be found at www.ist-africa.org/home/files/Tanzania_ICTPolicy.pdf

in Tanzania. At the stage of preparing the final draft, a large meeting was held with 400 participants, including people from outside Tanzania, such as Sweden and Ethiopia.

The University of Dar es Salaam played a key role in the ICT policy process. The ICT Task Force was, as noted, 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 members of the university staff were brought into the secretariat to formulate and write the drafts. The draft was developed through a very broad and open anchoring process, thereby moderating the academy's preferential right of interpretation. This role of UDSM can furthermore be viewed as an advanced technopolitical "negotiation" between the University and the Government. We should bear in mind that, at that time, ICT knowledge experts in Tanzania were mostly located at UDSM or trained there, as it was the only institution with a technical faculty in the country[18].

The national ICT policy provides a substantial understanding of the status of ICT in Tanzania, as well as emphasising ten strategic areas for ICT and development, and is a very well-formulated document. One of the central statements concerns the need for Tanzania to move from being mere consumers of technology to becoming designers and manufacturers of ICT[19], which will be commented on below.

The ICT policy stopped at Chapter 4. Longer texts in earlier drafts addressed more of the implementation strategies. It is important to note that, from the outset, the Task Force agreed not to locate within Government the body that would deal with the implementation of the ICT policy. The Task Force also wanted it to have sufficient authority to coordinate and oversee ICT issues in the ten focus areas in both the public and private sectors. Designing such an organisation proved to be a daunting task. Hence, the decision by the Cabinet to shorten this chapter and defer it until later did not come as a surprise but reflected the thinking of the Chair and 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*

18 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).

19 See chapter 3.3.1 in the National ICT Policy document.

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.

The role of the university

Background

The University of Dar es Salaam was born out of a decision taken on 25 March 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 of 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 operated a library, the University Computing Centre Ltd, Dar es Salaam University Press (DUP) Ltd and two centres: the Centre for Continuing Education and the Centre for Entrepreneurship Development, as well as consultancy activities within the Economic Research Bureau and the University Consultancy Bureau (UCB). Other centres included the African Virtual University Learning Centre (AVU-LC), offering degree, diploma and certificate courses in computer science using open and distance education platforms; the Technology Development and Transfer Centre at CoET; and the Instructional Technology Resources Unit (ITRU), which imparted skills to academic staff to enable them to conduct online instruction. UCB handled consultancy at university level. There were other units at college, faculty or institute level — for example, 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 postcolonial 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 elucidating insight into the processes of transforming the colonial African universities into national universities. The situation was particularly precarious in a political climate characterised by single-party states, including Tanzania. The threat of increasing state repression of 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 described 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[20].

> *As part of the ongoing transformation programme, UDSM has initiated a number of reforms aimed at improving its main outputs (teaching, research and services to society) through ICT. The improvement of ICT aims to suit the needs of students and staff, improve 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 and to ensure sustainable academic programmes.*

Relevance

The Vice-Chancellor emphasised 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 relevant to the developmental aspirations of the people. Addressing development concerns means that the University must have an impact in whatever area.

The transformation should go deeper into the academic culture, the Vice-Chancellor argued. Out of the 16 objectives in the strategic plan of UDSM, one concerned the change of the organisational 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".[21]

At the Tanzania Commission for Science and Technology (COSTECH), 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 users of society. The question of relevance seemed to be sensitive for COSTECH, which wanted to own that question. "We think that universities 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 conceptualise reality of things…. Many universities solve academic problems, not practical problems". Examples of preferred projects for students were databases of the villagers, repackaging local knowledge and multimedia tools 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.

20 Retrieved 2004 at www.sida-sarec.udsm.ac.tz

21 from interview 2003 09 12

UDSM as a national resource for ICT infrastructure

The experience of deploying ICT at the University started in 1993 with the establishment of a university email system[22].

Transfer of technology needs a special organisation, like marketing intelligence in the private sector, but nobody thought about that at the University. The early 1990s was the time of the Internet's arrival. It was UDSM that brought the Internet to the Tanzania Telecommunications Company (TTCL), not the other way round. In many countries the telephone company gives access to the Internet to the university[23]. Internet powered the headquarters of the telephone company. However, in this period there was a lack of knowledge about the Internet. Both the university staff and management clearly saw the benefits of the 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 an Internet backbone in every region of the country. The challenge for the University in 2003 was to look at how to transfer the technology to industry. As a result of 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.

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22 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.

23 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 KTH-NOC 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).

Gradually, the prices for Internet access came down and several ISPs[24] entered the scene. When the University started to charge for the services, there was no licensing 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 university staff to continue with ICT development. This technology was appreciated as exciting, and they were the only people who knew how. 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 gained its formal status as the College of Engineering and Technology (CoET). The university staff engaged were eager to see Tanzania on the map, as they knew how to build the systems. Both the Government and the University were trying to find the easiest way to implement the Government's own processes and demands, which involved monitoring, evaluation and easy communication. UDSM was trying to provide those kinds of solutions.

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 its own efforts. After less than four years of implementation, UDSM recognised that ICT development was not 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 a 24-hour 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 nor operating legally. 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 networking and held 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 it. The Centre was also conducting a project to develop 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 in the development of ICT at UDSM. The first was the existence of a University ICT policy and master plan that was widely accepted. The ICT policy was approved by UDSM in 1995 and implementation started in 1996. The second important factor was the championship of and support by the top management of UDSM.

24 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.

CoET at UDSM

As CoET was a key actor in the emerging ICT sector in Tanzania, and as the contexts of my main concern are situated in faculties of technology, I am going into some detail 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 the 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 1,350, while the number of postgraduate students was 171. At the same time there were 36 PhD students, including four female PhD students. 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)[25] as an organ of CoET and thus part of UDSM.

The main motive for CoET was to fulfil one step of the University's strategy of reducing duplication and pooling 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:

- 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 interests of suitable exploitation and local processing of natural resources in Tanzania, ultimately leading to the innovation of technical products and production processes for local industry; and
- to provide expert professional services in the form of consultancy to industry as well as to 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;
- the long-term agenda for UDSM was to increase output, to get distance students onto campus and to provide distance education also within the campus.

ICT literacy was very much in demand, which meant that graduates from CoET were absorbed very quickly by industry after receiving their bachelor's degree. The demand was expected to be even higher when rural areas were also reached. There was a major

25 PM Sida SAREC 2003 04 28 to the research board of SAREC.

problem — the biggest headache for CoET — in keeping good students for research and an academic career in order to build the capacity needed at the faculties. Professors found themselves lucky to retain those students who really wanted to stay at the University — about one in ten. The students concerned found jobs better paid than at the University. The motivation to pursue a PhD in ICT was further decreased by the lack of interest from the private sector in valuing staff with a PhD degree.

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

University Government relations

As indicated above, the relationship between UDSM and the Government showed some complications. The political situation in Tanzania — with the introduction of a global market economy and a multi-party system — was changing this relationship. Not least, the national ICT policy process in Tanzania revealed other kinds of links between the University and the Government, both at the level of knowledge-sharing and at a personal level, as mentioned above. In addition, the Minister for Communications and Transport at the time was a professor from UDSM. There are professionals who, in the same person, hold competencies as ICT experts trained at the University, as formerly employed experts in ministries, and as managers in ICT-related companies that were partly privatised. That person was, in themselves, an innovation system. In a country of scarce resources, with knowledge and technical skills concentrated in a single institution — the University — this situation was not unique and held certain potential.

Governmental support to higher education and research

Only undergraduate studies at universities in Tanzania were supported by the Government, including allowances for transport, books, etc. Postgraduate studies were managed by the University itself. There had previously been no fees for higher education. The system was, at the time, in a transitional stage. The Government reduced the number of grants as well as allowances, hoping individuals would be willing to take over. The conflicts that arose were addressed, in part, by introducing higher education on a loan basis for students who could not afford fees and living expenses during their studies. The University assisted the Government in drafting a framework (umbrella) bill for this purpose.

Tanzania had no national research fund. For the development of research there was no money from the Government, which supported only undergraduate (bachelor's) studies — and even that at a decreasing level. The Committee of Vice-Chancellors put forward proposals to the Government on this matter. Sida/SAREC firmly stated[26] that support would be continued only if the Government, through the relevant ministries, was willing to engage in a dialogue on the role of research and knowledge in Tanzanian development, and if this dialogue was reflected in strategic interventions from

26 PM 2003 09 22 to research board of SAREC.

the Government. At CoET, they looked to the evolving research-financing system in South Africa. An East African regional co-operation mechanism in research financing was thought likely to come at a later stage.

The ICT infrastructure issue

From the Government side it was stressed that a great deal remained to be developed — for instance, how to connect key national institutions, such as major hospitals. In 2001, a conference was held at UDSM concerning networks between the University, the Government itself, other training institutions, and telecoms companies. The question was whether, if the University took a leading role, others would follow. There was potential in an institutional arrangement linking universities and other institutions, thereby helping them to develop their own capacity. At the same time, it was cheaper to run and develop from the existing networks.

For ICT implementation in society, University computing centres were distributed across different locations. Pilot centres for distance education — mostly short courses — were already in place, for example 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 do this regularly every 5 years in order to determine whether they were moving in the right direction and to evaluate the relevance of research and other activities. UDSM invited the Government and the industry for discussions. This led to a revised curriculum every 5 years. 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. This situation was connected to the transition from a socialist to a 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."[27]

The University is in different ways connected to innovative production at the industry. For SMEs, it has a twofold effect through graduate employment. Industry is recognized to be changing to more sophisticated activities and open for more interaction. Some researchers and faculty members were assisting different industry sectors, such as mining, agriculture, fishing and manufacturing. UDSM had an Entrepreneurship Centre. As thoroughly presented by Mwamila and Katalambula (2004) and briefly commented on by Diyamett (2004), CoET had two major outlets for technology

27 Interview at pCET 2003 09 15.

development and innovation: the Bureau for Industrial Cooperation (BICO)[28] and the Technology Development and Transfer Centre (TDTC)[29]. BICO focused on consultancy and services, whilst TDTC focused on technology development and transfer with the important role of technology brokerage.

When considering the issue of ICT consumption and production in Tanzania, situated experiences from various perspectives revealed alternative strategies. "In order to be active on the production side, the easiest way is to make ourselves credible as big consumers."[30] This strategy had somewhat started in the Government in finding retail levels such as the reduction of taxes on computer equipment. Bringing down the prices meant supporting the local second-hand market. When large manufacturers received an order for, say, 50,000 computers, they would investigate how to improve computer design for the Tanzanian environment (dust-proof, water-proof). A disadvantage could be turned into an advantage. Manufacturers showed considerable interest in this regard.

Another line concerned the problems in the education system. The students did not have the skills the market needed. One company representative stated that one has to find the right skills in Kenya. If ICT and education are not driven by demand, the education system must be reconsidered. The transformation of teacher training was crucial as well.

Science education faced a major challenge. 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 subjects 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.

Emerging ICT innovation systems

It is not self-evident to use a concept such as an innovation system in a Tanzanian context, first because it is originally a Western formulation and experience, and secondly because the situated relevance of the concept is still evolving. The ICT discourse is heavily Western-dominated with only a few openings for African-situated interpretations and experiences.

As a starting point for discussion, an understanding of an ICT innovation system as a function or process of close cooperation between the Government (national or local),

28 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)

29 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)

30 Interview at Civil Service Department of the President's Office 2003 09 11.

the University and the private sector made some sense. The ICT Task Force was seen as unique in fostering partnership. The three main stakeholders met in the Task Force and produced a joint policy that supported this cooperative approach. Those active in the Task Force emphasised the need to encourage the private sector to be patient. The impatience of the private sector was a real challenge because the Government was experienced as a slow-moving institution. Initiatives from the private sector were more likely to be reshaped by the ministry. Harmonising the different interests — not least those who wished to preserve the status quo to defend old privileges — was not easy. Adding the interests of the University made the situation even more complicated.

The University was regarded, if not as the major stakeholder in this system, at least — given the severe shortage of trained professionals — as 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 statement was made in 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[31].

A practical example of an ICT innovation system in Tanzania is the case of the Tanzanian Telecommunication Company Limited (TTCL). TTCL was a state-owned company. After privatisation the Tanzanian state remained the major owner. Although TTCL expected its monopoly to disappear within a year or two, it retained a lead in operating the national network. The interests of the Government and of the associated private sector were connected to the University in the following way at TTCL. The company was used for research and training as well as for connectivity for the University. Some master's students were funded by TTCL. The students' project work constituted pilots, implying mutual learning for both the students and TTCL. They jointly captured important knowledge. The University and TTCL worked together as employers, with a number of students working at TTCL. In addition, TTCL funded a professorial chair at UDSM. The need for mutual development was recognised and supported by having University-trained researchers as managers at TTCL.

Several University professors considered the private sector to be very unfair. The sector did not want to invest in research for mutual development. Companies were only looking for graduates sponsored by someone else, leaving the whole burden to the Government. The professors gave the example of one firm with a contrasting attitude: a mobile phone operator that believed it would need graduates in future and was prepared to support them, planning to fund students for up to two years to bachelor's level. Contacts between the company and students were established. This was a kind of new model the company wished to keep confidential to retain a competitive advantage over other firms seeking the same students.

31 18th of February 2004

Another preferred alternative was for the private sector to team up with the University. Instead, the sector often cooperated with foreign consultants. The question of why they chose foreign consultants when local consultants were available was raised. The private sector argued that income taxes should provide resources for education and research.

Many would agree with the professor at UDSM who stated that Tanzania's university heritage rests heavily on Western ways of knowing. The same applies to industry and, in particular, the Government. The changes in Tanzania had not yet stabilised. The Government was unable to comprehend and cope with the emerging trends. Generally, the University and the engineering sector have had a strong relationship with the Government from the beginning. The sector depended on the Government and appreciated the Government's role in recognising the training of students as an input into the development of the country. It was considered important that the University was involved in policy and strategy development.

ICT implementation in a postcolonial situation

Pressing issues for ICT implementation included the absence of a clear owner at a high political level. The Ministry of Communications and Transport was coordinating efforts to identify an appropriate owner who could channel and align all initiatives. A government representative argued that the issue was not whether a single ministry acted as owner; ICT concerns many ministries. What was needed was a matrix function to integrate ICT, led by innovative people. Another issue was funding. As the largest employer, the Government should be the largest provider, in order to reduce the uneven distribution of connections. Regarding ICT infrastructure, one idea was to utilise other sectors to build networks — for example, combining with railway construction and maintenance — to avoid wasteful 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.

The University did far more in terms of infrastructure and hardware development. Very little priority was given to content — for example, local content — even within educational institutions. Situated development in these areas was proposed to be driven by organisations such as the East African Community, the Southern African Development Community (SADC) and the African Union. A single country might not have the critical mass to address these issues. They can be tackled more efficiently at a regional level. Addressing context-sensitive content development was considered a major regional issue.

When integrating ICT into development programmes, low-income countries such as Tanzania are necessarily disadvantaged. The partnerships Tanzania enters are not always in its favour. One interviewee 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 rapid growth of the wireless telecoms sector shows how great the potential of ICT can be in Tanzania. The implementation and widespread use of mobile phones with prepaid functions has amounted to a near technological revolution. Such technology for direct communication between people appears appropriate, relevant and affordable to a much broader group than the high-income elite. As in other African countries, mobile phone use has rocketed in Tanzania. Estimated market penetration rates in Tanzania's telecoms sector in 2015 were: mobile 75%, fixed line 0.3%, Internet (3G, 4G) 26%[32].

Emerging innovation system in a Mkukuta[33]context

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

A number of stakeholders are involved in making things happen, indicating that ICT is much more than a matter of technical infrastructure and technical systems, particularly when embedded in emerging innovation systems. Experiences from Tanzania show that the introduction of ICT, for instance in the form of Internet communication, is a delicate process with technopolitical as well as broader political dimensions. Technical faculties and top management at the universities have been active and proactive partners. However, in the complex web of material, cultural, social and economic actors[34] within ICT development, one of the key issues is accessibility for low-income countries and for poor women and men. Opening up and increasing access to information, knowledge and communication via ICT is a non-linear process.

32 www.budde.com.au/Research/Tanzania-Telecoms-Mobile-and-Broadband-Statistics-and-Analyses.html?r=51 retrieved 20160419

33 Mkukuta is the poverty reduction strategy of Tanzania.

34 For a discussion of diverse actors in ICT contexts, see Elovaara 2004

A postcolonial situation emphasises the concern with relevance. The Vice-Chancellor of UDSM is explicit about relevance as the central mission for the University's assignments — research, teaching and services to communities. To be relevant in a wider context than the traditional "ivory tower" conception of universities entails a number of challenging impacts on the university and its transformation ambitions. This substantial issue is fully recognised 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 in a globalised world are present and cannot be denied. A postcolonial country like Tanzania has significant potential to meet the challenges of relevance and to be in the forefront when it comes to the transformational tasks that all universities face in a knowledge- and technology-dependent society.

If we use the triple helix model simply as a way of recognising the collaborative practices in which the university plays one of the active roles, the relationship between the university and the Government becomes a complicated balancing act. This balancing act differs in many — though not all — respects from the situation in, for instance, Sweden, and is due to the history of universities in formerly colonised countries. The situated knowledge about UDSM presented by Luhanga et al. (2003a, b) is an imperative reminder to me and others of the vital importance of context-dependence in every effort at ICT development and knowledge-system transformation.

A fourth actor, alongside the three main actors — university, industry and government — in the triple helix model for technology development has been recognised in "technology-related intermediary institutions"[35]. This fourth actor points to the importance of a broker function. The broker role, including knowledge management, is often overlooked in cooperation processes between industry, university and government, not least in a Northern European context. It is notable that this function is identified in a Tanzanian context and strengthened by the observation that institutions of higher learning, such as universities, have a major role to play in the generation of knowledge that enables the smooth functioning of these cooperation processes. We find the vital broker and related transformative functions also within the main actors, as observed at CoET and other parts of UDSM in the first decade of the 2000s.

The ambitions of UDSM and the Government of Tanzania (in the National ICT Policy) to foster ICT for poverty alleviation and societal development were (and are) serious and have a recognised pathway. Acknowledging the postcolonial context holds vital potential for innovative advantages, as well as for turning the Western ICT expert discourse upside down.

35 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 of postcolonial ICT is, for me, almost synonymous with 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 use 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 gave specific attention to the evolving information society[36] and convened 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 on the agenda, fostered especially by the WSIS Africa regional chapter. It is within the context of these issues that this chapter also briefly includes 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[37]

> *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 an emphasis on ICT is motivated by goals of transformation. The reasons for transformation are seen not only in the ongoing difficulties of achieving appropriate ICT system solutions, especially in low-income countries[38], but also in how we face contemporary processes of knowledge and technology development (Gibbons et al., 1994; Novotny et al., 2001). The prerequisites for the latter are still to be met and urge transformation, not least within academia and faculties of technology (Etzkowic & Leydesdorff, 1997). Academic ICT and its applications in society and everyday life draw our attention to the relationship between dominant actors, the university being one. This stresses the need for relevant knowledge about its prerequisites, resulting in transformation challenges within traditional universities. Feminist technoscience within faculties of technology is a driving force for the transformation processes in demand (Trojer, 2002). The reason is to be found in the identified potential of feminist ICT research, which meets some of the prerequisites for the discussed challenges, namely the potential to:

36 WSIS - World Summit on the Information Society

37 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).

38 See for instance 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 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 up preferential rights of interpretation in selections of standards, which are always reality-producing activities.
- indicate alternative directions for ICT applications.
- establish new arenas for developing understandings of the relations between research and politics.
- constitute a catalyst in the negotiations between, or better the co-evolution of, science and society.
- contribute 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"[39]. Experience reveals 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 that must also include the possibility of changing deeply ingrained structures such as gender structures. The concern to understand the underlying cultural and cognitive structures that are reality-producing in the evolving information society has been, and still is, central in feminist technoscience.

Participatory ICT design is emphasised 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 a complex understanding of gender structures.

An example is given by McKinley & Jensen (2003), who studied the emancipatory and participatory potential of a radio programme. The purpose of the programme 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 ex-

39 Lecture at Luleå University of Technology, March 5th 1998.

perts or investigated through interviews. Listener groups were also invited to produce the different programmes together with the production team. It turned out that both women and men listened to the programme 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 sexual abuse, domestic violence, etc. Through the radio, the women in these remote areas succeeded in connecting with each other, communicating about issues important to them, 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 problematises the discourse of equal access by showing its limitations, rendered 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, 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[40]. For development, the shift in 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 still seems to be characterised by a lack of leadership and understanding of new technologies, political instability and weakness in regional institutional building, several basic issues to address, and a need for ownership[41]. The imbalance in power remains and makes it difficult for 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 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 denaturalise the discussion of former colonies as nations in need of ICT transfer. As Albert Nsengiyumva has stated[42], all electronic technologies have been brought in from outside.

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

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

42 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 qualified teachers, especially in rural areas, as qualified teachers tend to move to urban centres. The problem is particularly severe in the science subjects, as science teachers often find alternative, more lucrative employment. At the University of Dar es Salaam (UDSM) and the Colleges of Engineering and Technology, a research project was developed between 2005 and 2012. ICT was tested as a tool to support rural secondary schools with teaching materials for science subjects (Kalinga 2010, Lujara 2010, Simba 2012). The University of Dar es Salaam has a strong mandate to focus research and education on areas that benefit wider society. The e-learning project was well aligned with this ambition. The use of open-source software (OSS) for the platform, and participatory content development and use, were vital to the project.

During the research process, a more nuanced understanding of the participatory aspects of e-learning evolved. Secondary school teachers participated in the initial phases and during the development of the material. The e-learning materials enabled varying levels of student participation depending on the platform's structure and the content. Actual participation in the schools depended on how prepared teachers and students were to shift the educational context towards a more interactive approach when the e-learning material was introduced.

A number of institutions in African countries have taken up the challenge of addressing the digital divide. Already in 2001, at the Regional Workshop on Engineering and Technology in Bagamoyo, Tanzania[43], researchers from East African countries identified common interests in finding ways to develop ICT for use in rural areas across their countries. The argument was that urban ICT had advanced much more easily. Appropriate applications identified for rural citizens include e-learning, medical advice, agricultural advice, promotion of farmers' agricultural products, and education through local computer centres in rural areas. This reduced travel costs and increased rural citizens' access to expertise located in urban or distant rural areas. In addition, e-learning can support practical and local knowledge-sharing outside the formal education system.

At the WSIS Africa Regional Conference[44], the participants identified a number of technical aspects of particular relevance for the use of ICT in African countries. These include African languages, voice/touchscreen applications, free software, and the development of content suited to local needs.

At the same time as postcolonial universities take on a role in developing ICT systems in their respective nations, the conception of the postcolonial has been problematised.

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

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

Although, legally, the nations have become independent, international relations in many ways remain the same. 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 introduction and development of ICT in a postcolonial context thus needs to be discussed in terms of postcolonial theory, if ICTs are ever going to become tools in and for the development of independent postcolonial societies (see Rydhagen, Trojer 2004).

Theories of postcolonialism have been criticised for not engaging with the material (see, e.g., Kapoor, 2002). However, technologies that produce realities need to be included in postcolonial theory, as technologies interact with human beings and societies in shaping the direction of future development (Anderson, 2002; Mejias, 2001). Previous research has discussed a number of issues relating to ICTs in postcolonial contexts (Rydhagen, 2004). The introduction of a specific ICT in a particular 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 from those in the literate and individualistic societies in which they were developed. Computers can be regarded as taking time from social interaction, thus being a negative thing. Similarly, the language barrier to the internet for people whose first language is not English is both real and symbolic (Leonardi, 2003).

Some information systems are successful in some respects but regarded as negative or failed in others. Employees might, for example, find a system useful for informal (but still work-related) purposes, while that usefulness is not reflected in increased income and thus is not considered successful at management level (or the opposite). Gender and other social relations are affected by ICTs, but not necessarily in ways that resemble previous experiences in other parts of the world (see, e.g., Apffel-Marglin & Sanchez, 2002). Technologies themselves, as well as how and by whom they are introduced, shape the impact ICTs have in postcolonial contexts. Old computers can be regarded both as 'good enough to start with' and as 'something the rich countries want to get rid of anyway'. How this will be taken into account in closing the digital divide remains 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 reorganisation 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 "postcolonial". "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 same 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 websites 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 policy, but they are 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 their own way of using it according to local understandings. The actual differences in local understanding and preconditions are also often underestimated. The colonial period has indeed spread European ways of doing things, but these ways have also been adjusted to local contexts. In Suchman's (2002) account, the perspective from locations outside the West magnifies the situatedness and fluidity of technologies, although these are equally present within the Western context.

Paraphrasing Donna Haraway, Suchman (2002) argues that "design from nowhere" is a result of the idea that technical systems can be constructed with minimal cultural connection "as commodities that can be stabilised 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 problematises the distinction between designer and user, pointing both to 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 postcolonial contexts 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 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 for 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, p. 165)?

Chapter 14

The message of Situated Knowledges, Mode 2, and NetPort as an innovation system spread to Uganda, reaching the Faculty of Technology at Makerere University. The bearer of that message was Dr Peter Okidi Lating. Our collaboration began with issues related to locomotives and has, so far, culminated in the Faculty of Technoscience at Muni University in Uganda. That story needs a book or two of its own. The following chapter shows what one person – the one just mentioned – with extraordinary drive, strategic skill, a generous heart and reliable networks can achieve in a traditional academic context through a Mode 2 approach.

From e-learning to university development in rural Uganda — co-evolution in triple helix processes[45]

To meet the needs

This chapter focuses on the development of an ICT/GIS research centre[46] in Arua District, Uganda, as part of an e-learning research project and linked to Uganda's Vision 2025[47]. Uganda's Vision 2025 has guided and influenced the development of the Poverty Eradication Action Plan (PEAP), its revisions, and other government programmes. It envisages a technologically advanced, competitive, self-sustaining and growing economy; a healthy, well-educated society with a high quality of life; regional integration and international co-operation; harmonious coexistence within a dynamic society where the citizenry is responsible, accountable, hard-working and peaceful; effective, participatory and democratic governance; and equal opportunities, empowerment and poverty eradication among the people.

The implementation of ICT in Uganda is not solely a question about 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. Therefore, African countries need local technological innovations to meet the needs of its people.* (Mwamila et al., 2004)

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45 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.

46 ICT refers to Information and Communication Technology and GIS refers to Geographic Information System

47 Uganda vision 2025 Prosperous people, harmonious nation, beautiful country: a strategic framework for national development. Kampala: Ministry of Finance, Planning and Economic Development, 1999.

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 considers 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 practise a multi-stakeholder process in Arua, as it is remote, insecure, and one of the poorest rural districts of Uganda. It lies approximately 500 km from Kampala, the capital of Uganda. The district is home to many Sudanese People's Liberation Army (SPLA) refugees. Travelling 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 the Congo (DRC), skirmishes near the borders frequently spill over into Arua District.

The backstory to the e-learning project and its geographical location in Arua began in 2002. A fourth-year electrical engineering student at the Faculty of Technology (FOT)[48] 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 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 is nowadays referred to as interaction research, as well as feminist technoscientific approaches (Trojer, 2006).

Situated e-learning

In March 2004, an ICT/GIS research team[49] 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 Dr Peter Okidi Lating, a researcher at FOT, who in 2004 began a study prompted by the questions of why there were so few female students at FOT and why so few students — male and female — at MAK came from secondary schools in rural areas. More than 80% of Uganda's approximately 35 million inhabitants live in rural areas, and, in 2004, over 90% of the few female engineering students came from "elite" and advantaged urban schools in Kampala and the surrounding districts of Mukono and Wakiso.

48 later became CEDAT, College of Engineering, Design, Art and Technology at Makerere University.

49 ICT refers to Information and Communication Technology and GIS refers to Geographic Information System

To illustrate how Situated Knowledges and results can emerge, we need to go into some detail. The team met district leaders, heads of department, headteachers of secondary schools, officials of the District Chamber of Commerce, the business community and women's groups. The team also visited Kuluva Hospital and several sub-counties in Arua District. Everyone supported the idea of FOT establishing an ICT/GIS Research Centre in Arua. In October 2004, the ICT/GIS team, led by Professor Tickodri Togboa, visited Arua again, addressed the District Council and set out FOT's intention to establish 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 cafés and FM radio stations in Arua. At the end of April 2005, the ICT/GIS team applied to have the former Chief Magistrate's Court buildings in Arua City allocated 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 in a specific location, from which a number of different learning processes unfolded.

The main target group for the e-learning project was two Advanced Level (A-level) girls' secondary schools, Muni and Ediofe, and one Ordinary Level (O-level) girls' secondary school. This was agreed after the researcher, Peter Okidi Lating, met the District Education Officer in Arua in March 2005. Hybrid e-learning tools were developed and implemented. In the context of the project, hybrid e-learning meant that the main course delivery platform was interactive multimedia CD-ROMs, while face-to-face classroom teaching remained. The principal reason for an ICT centre (the ICT/GIS Research Centre) in the project was the financial situation at both secondary schools: funds for the operational costs of sustaining internet connectivity were not available. A decision was therefore made to deliver content in CD-ROM format to the schools and to set up an ICT centre with VSAT internet connectivity[50] in the vicinity of the two schools.

Despite the differing approaches of the two headmistresses – not so much to the project itself as to the girls participating in it – the girls were enthusiastic. A number of notable situations occurred involving the girls and their teachers during the project. As a concrete result, analysis of the e-learning project showed that 41% of the students in their final year (A-level) passed and were eligible for university admission, compared with 0% previously, without the e-learning tools, for girls born and living in Arua (Lating, 2009).

Development and implementation proceeded in parallel, including the establishment of the ICT/GIS Research Centre in the centre of Arua. The Centre opened to the public in June 2006. A network administrator and a secretary were recruited. ICT co-ordinators from secondary schools were identified and trained as trainers. Ten sec-

50 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.

ond-year telecommunications engineering students from FOT served as teachers. They undertook their industrial training at the Centre. Up to 1,250 people were trained during June–August 2006 in basic ICT skills, internet use and working with email. These included district heads of department, secondary school teachers together with their students, and the general public.

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 practised in Arua, where one of the three co-operating partners was the university. In developing, as well as developed, countries, initiatives to introduce e-learning education most often come from universities, where we find skills from higher education, including pedagogical expertise and the technical knowledge and know-how.

Even in a low-income country such as Uganda, the university has resources that the other triple helix stakeholders may not possess to the same extent, namely the capacity to:

- take initiatives
- network at vital levels
- negotiate with authorities, donors etc.
- offer facilities
- develop the knowledge and technologies needed
- develop and offer training
- sustain long-term engagement
- keep the functional practices and cultures, that have been developed despite fragile political situations.

The co-evolving processes in the project, in which the Faculty of Technology at Makerere University took a substantial part, harmonised very well with the third core mission of the university in Uganda, formulated as "service to society". This mission is strongly linked to Uganda's national policy in the Poverty Eradication Action Plan.

The initiatives taken and the implementation carried out by FOT to build the foundations for the e-learning facilities in Arua are presented and discussed in detail in Lating (2009). Detailed stories of what really happened in Arua – 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

- Regional District Police Commander's Office
- District Police Commander's Office
- Chief Administrative Officer's Office
- District Medical Officer's Office
- District Forestry Office
- Resident District State Attorney's Office
- District Information Office
- District Engineer's Office

Schools

- Muni Girls Secondary School
- Ediofe Girls Secondary School
- Mvara Secondary School
- Arua Public Secondary School
- Arua Public Primary School
- Uganda Christian University, Arua Campus
- Arua Vocational Training School
- Arua Core Primary Teacher's College
- St. Joseph's College Ombachi
- Anyafio Role Model Secondary School

Hospitals

- Arua Hospital
- Maracha Hospital

Other Governmental Institutions

- National Social Security Fund (NSSF)
- Northern Uganda Social Action Fund (NUSAF)

The number of government and public-sector stakeholders is impressive and quite unique compared with a Swedish regional context. This strongly signals the stakeholders' recognition of the e-learning project's relevance and its impact in a place like Arua District.

Business sector as Triple Helix stakeholder

Thanks to a well-conducted anchoring process by the FOT team, the business sector of Arua District has been involved in the project. The ICT/GIS Research Centre was offering much-needed facilities. The District Chamber of Commerce has been cooperative. The following companies were involved:

- 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

In addition to the three main stakeholders mentioned above, the project and its facilities also involved other stakeholders, 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

- Researchers
- Students doing online courses in and outside Uganda
- Visitors to Arua
- Traveling Agents
- Students from schools outside Arua District mostly during holidays
- Community workers
- Indigenous people who mostly use the internet for communication with their relatives and friends in and outside Uganda.

The centre trained students from the West Nile districts, South Sudan and the Democratic Republic of Congo. District leaders from other districts in West Nile (Koboko, Yumbe, Nebi, Adjumani, Moyo) attended training at weekends.

Arua and impacts

The decision to establish an ICT centre had a significant impact not only on the town and its surrounding districts, but also on municipalities across the nearby border with the Democratic Republic of the Congo and Sudan.

The number of stakeholders is unusually high compared to a Swedish regional context. This strongly signals stakeholders' recognition of the e-learning project's relevance and its impact in a place like Arua District (Lating et al., 2007).

In 2010, the Government of Uganda decided to begin establishing a new university in Arua – Muni University. The ICT/GIS Research Centre was one of the seeds for the university's development. 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 to be developed was named the Faculty of Technoscience.

Institutional systems contain many grey areas and tacit practices that are difficult to grasp, operationalise and study (Haraway 1997a; Argyris 1991). Working across culturally different institutional systems, such as government, academia and the private sector, amplifies these challenges. The contributions towards a functional and sustainable system, which the Arua project illustrates, underline the conditions required for good learning environments and learning processes. The open-mindedness of the actors involved, a jointly identified goal, and the presence of the actors in the context of application show that 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 as follows.

- There was a policy gap in Uganda, as there was no policy concerning e-learning and ICT integration in the school curriculum. The capacity for ICT skills and pedagogical development was very low among teachers and school leaders. The ICT/GIS Research Centre had to begin with very basic skills development for teachers and other staff.

- Some district leaders did not see the relevance of the ICT/GIS Research Centre from the outset and did not accept it. Time is a quality factor here. Repeated meetings and discussions had to be conducted. Once the centre was in place and could demonstrate its objectives and facilities in concrete terms, it was easier for district leaders to understand and appreciate its advantages.
- The issue of misconception is a critical one. One district information officer continued to interpret the ICT/GIS Research Centre as belonging to his governmental department. He appeared at the centre and issued directives to the centre staff. This highlights the mission of the centre to be a neutral arena, and the need to maintain that neutrality. The centre was clearly a non-profit organisation; however, it was striving very hard to find ways to achieve long-term sustainability.
- The challenges linked to the business sector have been minor. One reason might be the good relationship with the Mayor of Arua, who was also the chairman of the Chamber of Commerce.

The principal outcome of the collaboration between the university, district and local government, and the business sector in Arua was the ICT/GIS Research Centre. The project has shown exceptionally good results in an unexpectedly short time.

What are the success factors? One of them is the framework of understanding provided by 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 characterised by a move from strictly disciplinary research to interdisciplinary research and further to transdisciplinary research and development. Here, our understanding of transdisciplinarity includes knowledge production in the contexts of application and implication. The triple helix process will not begin to work without a very important function, which is a broker or facilitator. That person must be trusted by all the main stakeholders and be able to move across all sectors, anchoring the project, getting people moving, etc. In this e-learning project, that person has been Dr Peter Okidi Lating from FOT.

The mindset of the partners involved appears to be changing from a linear development mindset to a collaborative development mindset. This transformation of mindsets is a condition for a triple helix process in operation. Another way of expressing the relationship between the stakeholders is to describe a shift 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 research'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 techno-scientific 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 ICT development, as indicated in the chapters above. What kinds of contexts of implications are recognisable if we focus on the combination of emerging innovation systems and the role of the university in East Africa? Cluster initiatives can provide such contexts. This chapter is giving content to cluster initiatives with examples from both Uganda and Tanzania. The content draws on the results of a research project focusing on the role of researchers in innovation processes within cluster contexts. Involvement in clusters differs from traditional research, which has mainly been assumed to be disconnected from practice, and also from consultancy work, in which collaboration is based exclusively on economic interests. The aim of the project was to understand how research linked to clusters can be understood within the academic system as well as by partner stakeholders outside academia.

As both Birgitta Rydhagen and I were driven by situated knowledge production that makes 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 our 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?[51]

Why clusters?

It has become a pan-African interest and engagement to foster the development of innovative cluster initiatives[52]. 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 populations working in small-scale businesses to support their families. Innovative cluster initiatives aim to develop 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 ecological challenges, or facilitate the management of marketing and sales. The involvement of government at national and local levels increases opportunities to adjust regulations and to support compliance, resolve disputes, and develop supporting mechanisms such as health services, public transport, or securing land rights for cluster entrepreneurs.

51 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.

52 See chapter 11

Individual businesspeople join in 'co-opetition' in the sense that they co-operate to solve shared problems or divide different aspects between them, while continuing to compete with their products in the market. Interested people in research institutions and other relevant organisations are invited to become facilitators for clusters and to take part in training workshops arranged for this purpose. They work voluntarily with facilitation, although some seed funding has been available and used to initiate the 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 1990s, the concept of sustainable development was disseminating through international organisations 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 as interdependent and should therefore take place simultaneously rather than being traded off against one another. The most cited definition of sustainable development is "development that meets the needs of the present without compromising the ability of future generations to meet their own needs"[53].

Almost a decade later, the United Nations formulated eight Millennium Development Goals (MDGs)[54] in the same spirit, giving human and environmental development quantitative and time-limited targets. For example, the number of hungry or starving people should be halved (from 1990) before 2015. Also, the number of child deaths and deaths among 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 sanitation with these facilities, and the decline in forest cover in each country should cease. 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 were followed by the 2030 Agenda for Sustainable Development[55], the SDGs, with their 17 goals now concerning all countries in the world and not only low-income countries.

Innovation and triple-helix model in low-income countries

It has been argued that innovation is an important aspect of a nation's capability to improve its economic situation and competitiveness (Lundvall et al., 2002). We can also

53 World Commission on Environment and Development (1987) Our Common Future, Oxford University Press.

54 http://www.un.org/millenniumgoals/

55 http://www.un.org/en/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E

argue that this is valid at 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 achieve success. Within the PACF cluster development, the concept of has been developed to emphasise 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 low-income countries can only be achieved when innovation and technological development are 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 Foreign Direct Investment (FDI) in low-income countries does not lead to the development of local firms, since patent rights and knowledge systems discourage international firms from interacting with local companies. On the 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 within locally established clusters, where social bonds and trust through face-to-face interaction facilitate the sharing of relevant and specific knowledge.

Fu et al. also argue that the socio-economic context affects 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 skilled labour is 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 that involve and train local labour. South–South collaboration is mentioned as an important issue in this respect.

Therefore, support is needed for domestic firms and researchers who have ideas and who are already in the process of production, construction and innovation. The triple-helix model for innovation has been shown to be successful in these kinds of contexts, since the interdependence between the key stakeholders — government (focus on social and economic development at a general level), universities (focus on knowledge development with social relevance) and private-sector entrepreneurs (focus on economic stability and progress at an individual level) — is recognised and leads 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) emphasises that the particular component in triple-helix interaction is that the participants share a focus on knowledge rather than on economic matters. That means firms are not particularly in need of a quick solution to improve their profit, and universities are not particularly in search of 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 particular bearing for universities in East Africa, where local business can often not be expected to contribute substantially with funds, but where know-

ledge for survival and adjustment to basic circumstances is a necessity. In this context, researchers and local businesspeople will together find essential knowledge faster than counterparts in more affluent 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 the local population. This potentially opens up opportunities for triple-helix collaboration both to develop research capacity and to improve local business. Well-established and well-resourced universities were more independent of the 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 the triple helix, since equal-level collaboration can become problematic. The governments in Africa have not taken the role suitable for the triple-helix model, and the universities have not had the research capacity to develop a culture of innovation and socially relevant knowledge. Instead, he argues, research has taken place in relation to international organisations and NGOs addressing internationally relevant issues with little effect on local development.

In the PACF context, the private sector was in most cases very basic and small-scale, often rural businesses with little investment and small, day-to-day income-generation activities. Innovation in this context was not narrowly defined as technological development, but also, by necessity, embraced organisational innovation such as the idea of co-opetition, sharing of methods with other cluster members, storage and transportation, marketing, exploring markets[56].

The universities in Eastern Africa are challenged to navigate between rigorous requirements for academic quality and demands for 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 low-income country will challenge researchers to bargain between scientific rigour and independence on the 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 the real practice of cluster initiatives look like? This chapter focuses on two cases. These were selected within the PACF network on the basis of the following criteria:

- Well established among the first pilots, to ensure extensive experience at both local and national levels.
- Connection to the dependence on and use of natural resources.
- Relevance of gender and environmental sustainability aspects.

56 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.

The two cases are located in Uganda and Tanzania, which 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 taking part in facilitator training, Engineer Balu Tabaro, 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 formed a local leadership group in the village of Katwe, representing salt workers (women salt-winners and men salt-extractors), salt loaders and salt traders. The local leadership group was in regular contact with the facilitator, Engineer Tabaro, and with local government on certain issues. Two researchers at Mbarara University conducted research on how to refine the salt to table-salt quality. This work was partly financed by the investment company JDG Africa Ltd.

In Zanzibar, Dr Flower Msuya approached a women's co-operative working with seaweed and soap production, after she had been trained as a cluster facilitator. The Zanzibar Seaweed Cluster Initiative was one of the first eight 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 main activity among seaweed farmers is to cultivate seaweed in shallow water, then harvest and dry it. It is subsequently sold to export companies for use in the chemical, food and medical industries in various countries. This is done on an individual basis, but the Cluster Initiative has been created with co-operatives and groups of farmers in different villages. Value addition is achieved, for example, through the production and marketing of seaweed soap. Improvements in cultivation have 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 (Institute of Marine Science, UDSM) and have involved training seaweed farmers in each local group. The Zanzibar government and seaweed exporters have been represented in the leadership team. In 2013 the cluster included 3,000 members in 11 villages.

A detailed description of the methods used in this research project is given in (Rydhagen, Trojer 2011).

Salt Lake Katwe

Lake Katwe lies 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 metres deep.

In 2005, it was reported that 10,000 people worked on salt extraction from the lake during the high season[57]. The number of permanent residents working throughout the

57 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.

year was estimated to be between 1,000–2,000, and activity can be low due to rainfall. The salt was sold for industrial use and animal consumption in Uganda. In 2011 around 1,000 women owned salt pans—fenced ponds along the shore where saltwater is evaporated and the remaining salt harvested. Their work consisted of checking and mending fences, removing waste and dirt, removing freshwater after rains, and scraping salt and salt mud for harvest and sale. Women could also work as labourers in other people's salt pans. A group of 130 men extracted rock salt from the bottom of the lake outside the salt pans. The lake is shallow, and the men walked in the water, cut pieces of rock with an iron bar and brought them to the shore on floats. On the shore, salt was weighed and paid for by women traders, who then sold it to buyers from outside the village, who collected the salt on trucks. The salt was carried from the lake to the trucks by male loaders, on their necks. Plastic was used to protect the skin from salt.

Salt loaders, salt extractors and salt traders were organised in formal organisations, where some of the profit was kept for collective use and as a safety net for those who became ill and could not work for a period. The collective fund was used to pay hospital fees when a member was in need. There were more women salt-winners, and they were less organised.

There was no storage for salt. This means salt could not be kept safe from rainfall or from theft. The salt workers therefore depended on buyers to appear regularly, and they accepted the price suggested in order to sell the salt.

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 had been to find ways to refine the salt. A major concern that the salt workers shared was to lose control over the salt as a resource and source of income. They feared that external investors might introduce salt refining but at the same time take control of the lake. Therefore, major suggestions for the cluster were to improve working conditions, in addition to improving or increasing salt extraction.

Saltwater is detrimental to the skin and to the private parts of the salt workers. Wounds were sealed with glue or patex prior to entering the lake, and private parts were 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 male extractors in particular asked for boots that protect the skin without causing overheating. Male loaders were searching for a durable material to place 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 consultations, as well as first-aid equipment. This request was forwarded to the local government.

Women salt-winners complained that some male extractors were destroying their pond walls when they cut rock from the lake bottom. According to the male extractors, this was not done on purpose, but some unorganised extractors were working too close to the ponds despite regulations requiring a distance of ten metres. Apparently, there were

regulations in place between the salt workers and within the groups, although not all were followed by everyone.

We were told that there was a major problem with rainwater and soil entering the lake. In part, this depended on increased rainfall in recent years. It was also explained that pan owners placed their pans in the path of streams carrying rainwater into the main body of the lake. As a result, the streams divert into the ponds, causing dilution. The women's groups reported that the loss of vegetation cover around the lake had increased water run-off and the erosion of soil into the lake. Cattle grazing was regarded as one explanation, but so too were cutting grass and bushes to mend the pond walls, and the collection of stones and small rocks for house construction. Reduction of the vegetation cover around the lake was a concern, and there was a call for local government to enforce regulations on cattle grazing and to replant suitable species. In some groups, it was suggested that researchers should be invited to provide environmental education and information to community members, in order to emphasise and legitimise regulations on grazing and the conservation of vegetation 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 refining without informing them. JDG Africa Ltd is an investment company, and there was fear they would try to make a profit from refined salt rather than contribute 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 said that he had visited Lake Katwe regularly for two 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[58]. For example, students of medicine and education were sent for 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's vision. The chemistry researcher confirmed that research done with the cluster had been presented at academic conferences, and he did not see conflict 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 for export to the food and hygiene products industries. Today, thousands of people — mainly women — cultivate seaweed on Zanzibar. The main work is to plant, protect, harvest and dry seaweed for sale to

58 See www.must.ac.ug

export companies. The seaweed Cluster Initiative was formed in 2006 with aims both to improve cultivation and to increase income through the local production of seaweed products. The cluster was initiated by Dr Flower Msuya, who was trained as a facilitator, related to her position at the Institute of Marine Science (IMS) in Zanzibar Town. The institute is part of the 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, in addition to their seaweed-farming activities. Adding seaweed increased the market value and visibility of their soap, which in turn increased their income and independence. Similar efforts were undertaken in other villages, although with slightly different approaches. In Kidoti village in 2011, women had soap-making machines, while in Bweleo, soap was made by hand. Other efforts focused on securing access to boats, since cultivation of the higher-value species is more successful in deeper waters.

Dr Flower Msuya was the driving force in the seaweed cluster and kept in contact with the cluster groups in the villages on a regular basis. She was also in contact with other members of the steering group, consisting of representatives from the government Department of Fisheries, the Department of Agriculture, and the private export company Birr. Direct relations with department officials facilitate the handling of certificates, resolving conflicting interests in villages, etc.

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 (2011), a few men were also members of the groups. Women stated during interviews that if they had male members, they feared the men would not be honest and would not work for the group, but would only turn up when profits were to be shared. They were therefore satisfied with the groups being women-only. However, Dr Msuya argued they would benefit from including male members, since seaweed farming requires male-coded work such as boat handling and diving. Women reported that working in soap production had given them higher self-esteem and higher status in the community, since they had work to go to in the mornings apart from farming. Finances improved for the individual women as well, since soap sales provided additional income. Only a small share of the seaweed was used to produce soap and other seaweed products in co-operatives in a handful of villages around the island, but the added economic value is important for the women.

Women farmers found that a major obstacle to further development was the marketing of seaweed soap. They were also reluctant to develop deep-water farming of the higher-value species of seaweed, due to difficulties with boat handling and diving. Dr Msuya tried to encourage collaboration with men who could assist, as well as women learning the skills 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. At the time for the study 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 the natural sciences.

Co-opetition and social relevance

Clusters aim to increase competitiveness without leaving anyone behind. The practices of co-opetition seek to reduce negative effects while amplifying the positive aspects of supporting private firms within the same branch. In both cluster cases, the Cluster Initiatives brought local buyers and producers together in collaboration, which proved beneficial for both. In the Katwe Salt Lake Cluster Initiative, it was clear that within the groups of loaders, extractors and traders, profits were divided equally, with solidarity towards those in temporary need. There was a balance between collective and individual sales, which was also evident in the Zanzibar Seaweed Cluster Initiative. Individual sales of dried seaweed were carried out in parallel with the collective production and sale of seaweed soap for the benefit of the group and its members.

We found genuine interest and engagement in Mode 2 research with social relevance at all levels at both Mbarara University and the Institute of Marine Science (IMS) in Zanzibar. The IMS Deputy Director noted that, with the success of the cluster efforts, Mode 2 research had permeated the Institute — from professors to students — who were trained to collaborate with, and contribute to, society during their study programmes.

It is our concern that Cluster Initiatives should not become merely consultancies with a financial focus, but remain genuinely collaborative and mutually beneficial in terms of knowledge. In a triple-helix process, where roles are blurred, research benefits from knowledge sharing with local entrepreneurs and from access to governmental information and opportunities for collaboration.

With knowledge sharing in focus, we find a clear demarcation between Mode 2 research and consultancy. Financial dependency, as described by Holland (2009), is not the same as the shared interests evident in the Cluster Initiatives. There was no direct financial benefit for facilitators in clusters, since most of the work was voluntary.

In the Katwe case, an investor paid for the research. Therefore, extra attention must be given to keeping the salt workers central regarding ownership of results and access to benefits arising from the research. Balancing the introduction of capital with maintaining control is delicate and may lead to the failure of clusters that require 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 machines introduced 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 formulated as an interdisciplinary and transdisciplinary activity, as in the Zanzibar case. Cultivation methods, technology for processing the harvest, organisation, and marketing were all addressed within the cluster. These issues were on their way to being raised in the Katwe case, but chemistry had mostly been disciplinary research.

With reference to Fu et al., the role of PACF in supporting cluster development in Africa seemed to be highly relevant and important for the development of local and

appropriate knowledge production. The establishment of cluster initiatives among local actors — including universities in the vicinity of small-scale business firms and local government officials — leads to innovation taking place at a speed that suits local stakeholders and in areas crucial for further development and competitiveness of the businesses. For example, in Lake Katwe, where salt has been extracted by manual labour for over 100 years, improvements in quality and working conditions can only be achieved through continuous experiments and on-site dialogue with salt workers together with local scientists.

Local, small-scale development of natural resources has contributed to the economic and social development of rural communities in both 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 working conditions and products.
- Mutual trust between 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 working conditions and positions in society.
- Consideration of the environmental situation to address aspects of continued utilisation of natural resources in the coming years.

Epilogue

Response-ability and research

Like a winding thread passing through tryings at risk, this essay collection is my endeavour to make explicit the situatedness and responsibility of research and researchers in the trouble, be it in the 'grand challenges' of our time or in the very local challenges of survival. The situation demands increasingly open and inclusive 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 of 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 experience at the Research Council of Norway, comments on the issues of grand challenges with 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 the 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". Arie Rip (2014) indicates that RRI is a kind of social innovation, ranging from discursive and cultural innovation to institutional and practice innovations. A social innovation, like a technological innovation, is new, uncertain and distributed. RRI, which began as a more transgressive idea, has increasingly been embraced as a concept by many, especially in the European Commission's Horizon 2020 Programme.

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 unrealised 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 that the responsibility for where and how these technologies travel, and for what uses, is 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[1] 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 to 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 'crosscutting issue' of the EU framework programme for R & I, Horizon 2020,

1 ISBN 978-92-79-43169-2, ISSN 1831-9424, doi 10.2777/9742

as well as its central place among the objectives of the 'Science with and for society' programme within Horizon 2020". I am looking for signs of the turn to "society in science" in the document. There are few, if any. I note that the Expert Group has struggled to open up a mandate for inviting processes of learning and development. This indicates resistance experienced by the Expert Group. It is thus reasonable to recognise that the report reflects compromises.

The transformation ambitions expressed in the report do not leave the policy-making context. But if we take Latour's statement above seriously, we all increasingly have to consider ourselves located in the policy-making context, including researchers and engineers. Although the recommendations for the use of the indicators are said to embody the principles of good governance, openness and participation through a network approach rather than a linear, top-down chain of command, the performance indicators for the recommended indicator criteria[2] are recognisable from what we have seen before. Within each of the eight indicator criteria, performance indicators are listed, predominantly quantitative. If, as an example, we take indicator criterion no. 3, gender equality, "counting heads" (percentage of women) dominates heavily. I find no signs of RRI gender equality indicators suggested that differ from earlier EU research funding programmes.

If little or no resistance to RRI occurs, then the chance increases drastically for the status quo and for no transformation—however needed—in science. Perhaps it is naive to think of the macro-level EU organisation welcoming RRI as a transformative intervention challenging all the investments made in the dominant science discourse (of Mode 1). Resistance can be recognised, as exemplified above, in the work done by skilful experts to rescue at least the existence of some RRI-related initiatives. This is worth learning from.

I continue to lean on Donna Haraway (1988), who made me aware that no innocent position exists, and on Jane Flax (1992) and her reminder of "the end of innocence" in the dominant discourse of Western academia.

Helga Nowotny makes 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) introduced the concept/figuration of involutionary momentum. What kinds of forward-moving potentials lie in this concept? Haraway was referring to an article by Hustak & Myers (2012). The article offers a

2 1. Governance, 2. Public engagement, 3. Gender equality, 4. Science education, 5. Open access/open science, 6. Ethics, 7. Sustainability, 8. Social justice/inclusion.

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 find 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". Motivated by Haraway (2007), they turn towards modes of relationality and "becoming with" while attempting to leave behind traditional evolutionary trees. It is inspiring to learn how the authors bring together feminist theories of affect[3], difference and responsibility, as well as Deleuze & Guattari's (1987) rhizomatic thinking. In addition, they draw on the work of Barbara McClintock and her "feeling' for plants" dynamic lives, which brings me back to Chapter 1 of this book. Deleuze & Guattari (1987) write about "creative involution", which Hustak & Myers appreciate as an approach that strengthens relations constituted through affinity. They cite Deleuze & Guattari 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-", such as co-evolution, co-production, co-operation and coopetition, in my thinking and writing. Perhaps it is time to advance into the 'in-' prefix and practise moving from co-evolution to in(-)volution. In the lecture mentioned above, Haraway was concerned with the use of sym-, as in sympoiesis, meaning collectively produced systems that cannot be defined by boundaries. This suggests that involutionary processes are characterised more by vitally necessary links than by separate entities co-operating. The rethinking of affective ecology concerning orchids by Hustak & Myers offers an example — indeed a figuration — of involutionary processes, which I believe could be used elsewhere. Another striking example of involution is the roughly two kilograms of bacteria in the human intestines — a co-existence without which neither we nor the bacteria could have evolved (or "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 scarce resources, and of survival — and especially by referring, in a figurative sense, 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 are always in becoming, in 'the no longer and not yet'[4].

3 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).

4 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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