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The Paths of Stem Cells

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In 2002 and 2003 there was a heavy debate about embryonic stem cell research in Denmark. The idea of using fertilized human eggs for research purposes was especially contested. The Folketing (The Danish Parliament) put down committees, and had hearings. In 2003 a law was passed that allowed research in embryonic stem cells. The eggs used for this purpose were to come from surplus eggs from IVF treatment. All research projects had to be examined and approved by the Danish National Committee for Biomedical Research Ethics.

During this debate an immense amount of actors had been mobilized: researchers, civil servants, politicians, patient-associations, law, money, parents to-be, IVF doctors, laboratories, technology, eggs. Soon, the government funded public embryonic stem cell research, as well as social science research in stem cells. Thus, I found myself mobilized as a part of a research group, consisting of 10 social scientists, funded by the Danish Social Sciences Research Foundation to do research in the effects and moral implications of embryonic stem cell research. The idea behind the publicly funded research was, that if the ground was laid by funding public research and changing the institutional and legislative setting, the industry would be ready to pick up any discoveries and breakthroughs and apply a clinical and commercial angle to stem cell research.

However, when I started localizing the private companies working with stem cells, I was surprised to see that only one company in the entire nation worked with embryonic stem cells – from mice - and none worked with human embryonic stem cells, even if they were said to hold the greatest promise, and the ones that the political process mentioned above had been all about.

It is a basic assumption within ANT and related theoretical schools that phenomena become real when their networks are long and allies are strong and well-disciplined (reference Latour, evt. Smart citat, spørg Torben). Biotechnological objects often have very long and strong networks. This applies even more to embryonic stem cells than the general biotechnological phenomena, as embryonic stem cells are connected to foetuses, or *embryos* as very young foetuses are called. Almost anybody or anything can connect to foetuses, the icon of *life itself*, and managing the future of foetuses is important to a whole line of actors. In the words of Donna Haraway,

> " […] the ubiquitous images of glowing free-floating human foetuses condense and intensify struggles over a […] new and disruptive technoscientific object of knowledge, namely "life itself". Life as a system to be managed – a field of operations constituted by scientists, artists, cartoonists, community activists, mothers, anthropologists, fathers, publishers, engineers, legislators, ethicists, industrialists, bankers, doctors, genetic counsellors, judges, insurers, priests, and all their relatives…" (Haraway, 1997: 174)

But, as implied in the Haraway-quote above, the allies found in the networks of biotechnological networks maybe strong, but they are rarely effectively disciplined, which gives the biotechnological networks a paradoxical status as both long and strong, but also as heterogenous, fragmented and undisciplined. The heterogeneity of the networks makes it very difficult to frame the biotechnological phenomena, including embryonic stem cells, as being one specific thing. Here, one could argue that framing is always difficult, and can never be complete – but I will argue that the difficulties are especially pronounced in respect to biotechnological phenomena, as these move easily over the crucial divide constructed between humans and things. Again, in the words of Donna Haraway:

> "The techniques of genetic engineering developed since the early 1970s are like the reactors and particle accelerators of nuclear physics: Their products are "trans". They themselves cross a culturally salient line between culture and artifice, and they greatly increase the traffic of all kinds of other traffic on the bridge of what counts as nature and culture…"(1997: 56)

This innate "transness" of the biotechnological objects is countered by the wish to create one, specific kind of biotechnological reality; a marketable reality. We are looking for one specific outcome of a network, and not any outcome – or any network, for that matter - will do. And in

this respect it seems that the connectivity of the biotechnological object hinders rather than facilitates the future reality of the object. The paper's ambition is to qualify and add nuances to this schism; an innate "transness" of the embryonic stem cell faced with the single framing destined for it.

As already indicated, I will discuss the reality destined for the stem cell using Michel Callon´s analytic concepts of *framing* and *overflowing*. The backdrop of these terms are, that for a phenomenon to become not only *real* (note; I am not out to deny stem cells or stem cell networks their reality), but a real *product* network-connections will have to be severed, and the object will have to be framed, making it less multiple, and more of a product. I will describe attempts to frame, and the overflows that follow. In doing so, I will describe a line of actors and their conceptions of the future thus painting a picture of a very `hot´ situation, where…

> "… everything becomes controversial; the identification of intermediaries and overflows, the distribution of source and target agents, the way effects are measured. These controversies, which indicate the absence of a stabilized knowledge base, usually involve a wide variety of actors. The actual list of actors, as well as their identities, will fluctuate in the course of the controversy itself and they will put forward mutually incompatible descriptions of future world states" (1998: 260).

In discussing the marketable reality of embryonic stem cells, this paper will try to make a list of "the wide variety of actors" and their "mutually incompatible descriptions of future world states", in order to characterize stem cells and the future of stem cell research. Unlike Callon, the framings that I will describe are not constricted to market framings.

However, the list of actors and futures in this paper is a snapshot and by no means exhaustive. It is a (primarily) national snap-shot, of a situation that cannot be described as nationally constricted. In other words; other lists could have been made, featuring different actors.

When discussing the futures projected by the different actors, I will look both at how past futures projected on the present, and present futures projected ahead have reality effects. This double vision is inspired by Brown and Michael's terms `retrospecting prospects´ and `prospecting retrospects´. They write:

> " The first of these `interpretative registers´ refers to the way the future was once represented, as distinct from the way it is currently represented. This process of recollecting past futures we have called *Retrospecting Prospects*, or people's memories of

> the future. The second register refers to what people do in the present with these recollections. That is, the uses that people have for these memories by redeploying them to manage or engage with the future." (Brown & Michael, 2003: p. 4)

I do not stick to Brown and Michael's terminology in a strict sense, primarily because of the focus they put on humans. What I do want to hold on to is their idea of two interpretative registers – one dealing with recollections of futures of the past and these recollections' impact on realities of the present, and a second one discussing the projections of futures from the present into the future and the projections´ potential reality effects.

Moreover, I supplement the idea of recollections of past future projections and present future projections with the Karnøe and Garud's terms of *path dependency* and *path creation* (2003), thus indicating that although I choose to be able to shift interpretative registers between these two types of futures, I still see them as connected in one *path*. However, Karnøe and Garud's conception of the path, presents the path as a coherent national and institutional phenomena. The paths I will describe in this paper is of a much more multiple – or even fragmented and deconstructed – nature, where agency can reside in the littlest things, not depending on human agency or institutional support.

Empirically, the paper is based on diverse texts from the public media, policy documents, scientific articles from the world of stem cell research, informal conversations with stem cell researchers and laboratory leaders from commercial and public laboratories in Denmark, one formal interview with the laboratory leader from the one Danish commercial laboratory working with embryonic stem cells, and visits to the bench of that lab. As indicated, the main focus lies within Denmark, as the data that demands physical presence is collected there. Broader data from media etc., however, also calls on the international situation.

Stem Cell Paths

Path 1: The Cell

Embryonic stem cells have been perceived as a new take on how to save ourselves from our biology. Ever since the breakthrough of molecular biology in the 60s the media and the general public has looked to this line of research for the miraculous cures of diseases that we have never before been able to free ourselves from. Our bodies and the diseases fatal to them, has been perceived as the one last thing humans could not control – the last frontier. Molecular biology opened the possibility that we would be able to control not only communication technology, space travel, and micro-chips, but our bodies as well. Molecular Biology is and has been

seen as the future of medical research both as diagnostic tools and as invasive therapies. Donna Haraway writes:

> "Two conclusions […] are obvious: (1) Molecular biology has major creative importance in practically every area of biology and medicine; and (2) fundable questions in the life sciences have conformed drastically to those compatible with the practice of biology as molecular biotechnics" (1997: 57)

Stem cells can be regarded as an example of one such biotechnological phenomenon based in molecular biotechnics and aiming at revolutionary therapies. It has been, and is still surrounded by great hopes for the future. The reason for the specific hopes invested in stem cells is that the stem cell can develop into any cell in the body thus restoring any disease in any organ. As in the words of Francis Fukuyama:

> In [one] scenario, advances in stem cell research allow scientists to regenerate virtually any tissue in the body, such that life expectancies are pushed well above 100 years. If you need a new heart or liver, you just grow one inside the chest cavity of a pig or cow; brain damage from Alzheimer's and stroke can be reversed. (2002: 9)

Unfortunately, the stem cells found in fully developed organisms (children and adults) do not have the potential to develop into any cell. Only one type of cell can do that – the embryonic stem cell.[1] The work that is laid out for the researchers is to take the embryonic stem cell, and

[1] Stem cells are classified in (at least) three different ways, the three systems together constituting a complex 3-dimensional matrix: First, there are the three developmental stages of the cell that are becoming increasingly known to the public: the embryonic stem cell, the naval-cord stem cell, and the adult stem cell. It is legal to do research on stem cells from embryos up to two weeks old. After two weeks the practice becomes illegal, which makes the embryonic stem cell non-existent as a research subject. The stem cell re-emerges approximately 8½ months later as a naval-cord stem cell. The naval-cord stem cell is within reach of researchers for fifteen minutes after the birth of a child. After that the blood coagulates, and the stem cells are no more. The stem cell next re-appears as an adult stem cell, found in the bodies of adults and children, for instance in blood marrow, producing new blood cells. In a research-specific frame, the stem cell exists only very briefly in its potent early stages. The first gestalt, the embryonic stem cell, is taken out of existence by law, whereas the second gestalt, the naval-cord stem cell, is eclipsed by the blood's immanent characteristics (coagulation). The brevity of the early stem cells´ existence makes the harvesting of them a central crux. Second, there is a differentiation made on the basis of the specificity of the stem cell. The differentiation is made between totopotent stem cells, pluripotent stem cells and multipotent stem cells. Totopotent stem cells can become any human cell, which means that these are the earliest cells of the embryo. Some argue that it is in fact only the fertilized egg that can rightfully be referred to as totopotent. Pluripotent stem cells can become different cells in different types of tissues, while multipotent stem cells can become different cells of the same tissues. This classification is in some ways coincident with the classification above, but it has central differences as well: The classification of toto-, pluri- and multipotent stem cells is not intrinsically connected to the development the `host-organism´. For instance, experiments are being

prompt it to develop into a certain kind of cell; a beta-cell, a muscle cell, a brain cell – changing its path, as it were.

Already, we meet the first obstacle in the realization or future path of stem cell therapy; prompting cells to develop in a certain way is an extremely difficult task. In the embryo, the first original cells differentiate into all the cells in the human body, which are all present when a baby is born. This proliferation happens primarily during the first few months of pregnancy. Little is known of how the stem cells "know" what cell to become. The researchers are faced with the task of copying this process that they have only a vague understanding of, and becoming able to control it. The researchers are only at the beginning of this immense task – known amongst diabetes-researchers as the Manhattan B-Cell Project[2]. A laboratory leader from a laboratory working with treating diabetes puts it like this:

> But at every step you have to figure out what molecular mechanisms are stimulating this process, what kind of things control at the proliferation of this stage. You could say, that you need a proliferation, simultaneously with blocking that they [the embryonic stem cells] continue in another direction, you want to propagate them, so you want to stop them from going in one direction and make them go in another. And that is the way it is at every step; you want them to choose the right direction all the time. So it is step-wise… and analogously to the atom-bomb, the Juvenile Diabetes Research Foundation in USA have used the same title here, that it is the The Manhattan B-cell Project. If you ever have to go from [stem cell] to [beta-cell], it is not something that will happen in a single laboratory.

When (and if) the immense task described here is fulfilled the researchers will have a cell – and then they will have to start working with how to make this cell into a therapy. In other words, if the Manhattan B-cell Project ever succeeds it is only the tender beginnings of the making of a cure for diabetes.

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made, trying to have multipotent stem cells (for instance from adults) develop `backwards´ and become pluripotent stem cells. Third, is a developmental differentiation – not an organism-specific development, as was the case above, but a cell-specific development. This is a differentiation between stem cells, progenitors and precursors. Progenitors and precursors are not considered stem cells, but immature cells that are maturing into one specific cell type.
The distinction between stem cells and the different types of immature cells is relatively new. This makes the differentiation between stem cells, progenitors and precursors a historical as well as a developmental one.

[2] Interestingly, the analogy between biomedicine and the Manhattan Project is not unique within diabetes research. Rather, every biomedical research niche seems to refer to the work that lies before them as a Manhattan Project. For a discussion of this phenomenon see Lenoir & Hayes, 1993.

Another obstacle is that to be able to provide treatments for everybody – providing that it is possible to have the cells differentiate to become healthy versions of the cell that has become ill, causing the disease in the patient – it is necessary to have stem cells representing the thousands of different tissue types assumed found among the human population. At the moment app. 50 - 60 types are available to laboratories. Having stable cell lines in laboratories is indisputably a more practical – and less ethically reproachable - solution than having each person cloned to provide suitable stem cells. However, establishing a cell line is not easily done. Stem cells have a tendency to divide, and differentiate. To establish a cell line, you will need them to divide, but without differentiating. This takes constant nurturing, attending to media and other laboratory techniques. In public laboratories there can be fewer the three researchers attending to the researchers, which means that this constancy is very fragile, and hence also the stem cell line. Therefore, even the cell line is an important obstacle. Third, the stem cell lines that exist at present are polluted with protein from animals. If the cell lines cannot be cleaned of this foreign protein, the cells will be rejected just as is the case with organ-donation.

Fourth, when treating patients with cells or cell-producing organs from other persons, you run the risk of the body rejecting the cells, parallel to the rejecting of transplanted organs. This is not a relevant risk when discussing stem cell treatment. Here, we face a different type of risk: the cells have a tendency to divide; indeed this is the capability that characterizes the cell. However, some researchers claim this tendency can become a threat if the cells divide uncontrollably while in the body, in which case it can create tumour-like phenomena, which could kill the patient.

The point of this list of obstacles is exactly that it is not complete, and that some of the points continue to divide the scientific community[3]. The point is, that obstacles seem to appear constantly and at places were no one expected them. Thus, from a medical/scientific viewpoint, the future of stem cell therapy is dependent among other things on the success of researchers to make the stem cells react to prompting and develop in a specific way, make stem cell lines, make enough stem cell lines, and make the stem cell lines available, and suppress the stem cells' alleged tendency to divide uncontrollably, and cleansing of the stem cell lines of animal protein.

The obstacles facing stem cell therapy are as major as the potential they hold. The future paths projected for the cell thus falls in two categories; grand and heroic ones, and rocky and halfway impossible ones. Both of these are plural, as the successful paths could mean success in

[3] For instance, some researchers claim that stem cells turning into cancer-like tumors only happens when the embryonic stem cell has been genetically modified.

the treating Alzheimer´s but not diabetes, or Parkinson´s but not stroke. Likewise on the less successful paths, the reasons for failure are multiple.

Path 2: The Egg

Embryonic stem cells for research come from surplus fertilized eggs from IVF treatments[4]. The connection between the two seemingly separate frames of biotech research and infertility treatment are created in the following way;

Research in embryonic stem cells needs fertilized human eggs up to 2 weeks old. Accordingly, researchers need fertilized human eggs.[5] This is not an item you come by easily. Not only are the eggs embedded deeply in the female body; they are also entities that are surrounded by parental love, both individual and generalized.

In IVF treatments we witness the rare situation of human eggs being taken out of the female body. In a petri-dish, several of them become fertilized. However, there are health risks for mothers as well as children connected to multiple pregnancies, and therefore a maximum of two eggs are placed in the womb of the woman. In the petri-dish 4 – 5 eggs are left. What to do with them? Throw them away? Give them to another infertile woman (illegal in many countries, Denmark one of them)? Or donate them to science?

IVF treatment and stem cell research is connected through the rare entity of the human fertilized egg found outside the human body. This connection allows a range of ethical and moral issues tightly associated to the embryos to overflow the IVF frame and literally flood the would-be frame of stem cell research. The future traditionally projected for the fertilized egg is that of becoming a child. Projecting other futures for the eggs - especially as the eggs belong to infertile couples - is difficult, to say the least.

The story of the paths of the eggs is quickly told. It is not complicated or hard to understand, as was the case with the path of the cell. However, the path of the egg is overwhelmingly important; the future projected for the egg – becoming a child – is very powerful, and the suggestion that it is equally important to become a product (albeit a life-saving one) seems profane to many. Competing with the path pointing towards "becoming a child" is playing against the odds. In the words of George W. Bush, who appeared before the press, surrounded by children

[4] IVF treatment is becoming more and more common. It is experts estimated that between 10 and 15 percent of Danish couples are infertile, and approximately one child in 20 are the result of IVF treatments. (Weekendavisen 23. juli, 2004)

[5] Another possibility of acquiring material for research in stem cells is to import stem cell lines – for instance from other countries with less strict regulations. Thus Danish researchers often use Swedish stem cell lines. But naturally, these lines also originally come from eggs acquired through IVF clinics.

created using IVF-techniques, in response to the House of Representatives voting in favor of expanding federal funding for embryonic stem cell research:

> The children here today remind us that there is no such thing as a spare embryo", Mr. Bush said, amid the squeals and coos of babies cradled in their mother's arms. "Every embryo is unique and genetically complete, like every other human being. And each of us started out our life this way. These lives are not raw material to be exploited, but gifts. " (New York Times, 25th May, 2005)

Path 3: Money

In the public debate about stem cells – and within the community of social scientists looking at stem cell research of which I am part – the consensus have been that it is crucial for stem cell research that there is a good supply of fertilized eggs. It has been assumed obvious that there would be an industry waiting to use the eggs and the findings of the publicly funded researchers. Without the crucial actor of the egg, the network would not be long enough to support the practice of the research. Thus, significantly, when I first found that no commercial research in embryonic stem cells was taking place in Denmark, my reflex reaction was to assume that there were not enough eggs, or maybe rules and regulations still stood in the way somehow. The group of social scientists working with stem cells that I am a part of, did not contradict me.

When I went into the field, however, I was much surprised. Laboratory leaders of commercial laboratories told me that the problem was *money*. But why was money such a scarce resource when embryonic stem cells allegedly hold such promises? The answer proposed by the biotech companies that have worked with stem cells, but has stopped doing so, or have considered working with stem cells, but have not done so, is the same: The short time span of venture capital. One laboratory leader – who had just cancelled the company´s research in stem cells aiming at treating Parkinson´s, told me that for venture-capital it is a very long time to wait 5 - 6 years to see returns of investments.[6] Likewise, another laboratory leader states in an interview that private funds – from farmaceutical companies or venture capital - is practically impossible to come by:

> … it is extremely expensive, and there are companies that cannot shoulder that, because, you can say, the risk, the chance that something will come out of that product is ex-

[6] Not only is the future of biotechnology in general, and stem cells in particular, very uncertain, investments are also very expensive. Thus, it takes about 160 mio. Danish kroner to finance a biotechnological company which develops pharmaceuticals to exit, while it takes 50 million to do the same within software development. (Vækstfonden 2004: p. 3)

> tremely small, but just to test the possibility of there being a microscopic chance that it worked, no private companies are willing to take that risk. (Interview, april 2005)

Meanwhile the same laboratory leader, and the people working in the lab, states in conversations that a treatment against diabetes based on stem cells is – at best – 10 – 15 years away. And then you have to start the clinical trials adding another 6 – 7 years. The incompatibility of the time cycles within research in embryonic stem cells and venture capital is so extreme, that it becomes practically impossible to enrol the crucial actor of money in the network

It seems that past futures plays an important part in shaping money's precarious part in this story. Venture capitalists remember too vividly the expectations and money that were invested in the IT in the 90´s, and the disappointments that followed in 2000 when IT-shares on Nasdaq sold for about a tenth of their value six months earlier. The IT-bubble was a story of investors that believed in dreams and invested in futures[7], and were wrong. Investors were revealed as gullible and naïve. Soon after came the les financially disastrous biotech-bubble, which again proved that investors believed to lightly in promises put forth by industries.

Moreover, the Human Genome Project has stressed the feeling of disappointment. But the future of the Human Genome Project projected in the near past was grand and horrifying. The Human Genome was believed to be the human "cook book". When the Human Genome was at last decoded we would be able to read people like open books, seeing the genes that made them what they were, diagnosing diseases before people got ill, curing diseases in advance by means of gene therapy. But we would also be able to "diagnose" homosexual tendencies in foetuses, for instance. The question was; are we moving to fast into the Brave New World, and what will we loose, when we have the chance to discard not only diseases but character traits such as homosexuality? The utopian and dystopian future projections fought to gain control. What no one expected was that nothing much would come of it. Five years after the revelation of the Human Genome Project in 2000 neither the utopian or the dystopian future projections have become present reality: No cures for any disease have been discovered in the wake of the Human Genome Project. No foetuses have been aborted on account of homosexual genes. In fact, nothing much has happened at all. But the retrospected prospects of the Human Genome Project still have important reality effects today: Venture capitalists promise themselves never again to be so gullible as to believe in something as close to science fiction as The Human Genome Project. Thus, when Donna Haraway wrote in 1997 that …"fundable questions in the life sciences have conformed drastically to those compatible with the practice of biology as mo-

[7] For a description of the high of the dot.com era, which preceded the bursting of the bubble, see Boutaiba 2004.

lecular biotechnics" (2007: 57), this is an exemplary pre-Human Genome Project statement. Now, it seems that money is no longer as willing to connect to the networks of molecular biotechnics as they were. Thus, policy-makers cannot rely on the industry to pick up on the research done in university laboratories. If the therapeutic reality of the stem cell is to be, public funding is needed further along the path as well.

Path 4: The Patients

In 1994, former American president and national icon, Ronald Reagan, let the public know that he was sick with Alzheimer's dementia. 10 years after, on the 5th of June 2004, just before the republican campaign for George W. Bush second term as president, 93-year-old Ronald Reagan died.

In the years before the death of Ronald Reagan, present American president, George W. Bush, had given limited federal funds for research in embryonic stem cells and restricted this type of research with a number of legislative hindrances, because of moral and ethical concerns regarding the performance of experiments on human embryos. Thus, federal funds cannot be used to grow stem cell lines from fresh embryos, but only to do research on stem cell lines that were made before year 2000, or on adult stem cell lines. Meanwhile, there is no restriction or control on privately funded research.

The fatal illness and resultant death of Ronald Reagan had strange effects on the republican presidential campaign of 2004. The Republican Party is traditionally associated with conservative values, especially when it comes to reproduction. Firm anti-abortionist and pro-life campaigners, embryonic stem-cell research and therapies are a far cry from traditional republican politics. However, the illness of Ronald Reagan started changing people's minds. Former first lady, Nancy Reagan, asked president Bush to reverse his course on stem cells, and stop limiting the funding for research. Months later we witnessed the strange vision of Ron Reagan, Ronald and Nancy Reagan's son, speak at the democratic convention, supporting John Kerry's candidateship, because he, Kerry, was in support of embryonic stem cell research, whereas the republican candidate, George Bush, was not. Ron Reagan ended his speech in the following manner:

> "In a few months, we will face a choice. Yes, between two candidates and two parties, but more than that. We have a chance to take a giant stride forward for the good of all humanity. We can choose between the future and the past, between reason and ignorance, between true com-

> passion and mere ideology. This is our moment, and we must not falter. Whatever else you do come November 2nd, I urge you, please, cast a vote for embryonic stem cell research."
> (http://www.dems2004.org/site/apps/nl/content3.asp?c=luI2LaPYG&b=125925&ct=159643)

Meanwhile, new Californian senator, Arnold Schwarzenegger, was in favor of embryonic stem cell research, and on the 2. November 2004, 59 percent of the voting Californians voted for "California Proposition 71", allocating 300 million dollars for 10 years to stem cell research, thus making California one of the central regions of stem cell research in the world. The proposition was backed, both morally and financially, by business icons such as Bill Gates, as well as former movie stars, Christopher Reeve[8] and Michael J. Fox[9].[10]

This story is obviously about new and unexpected connections between diseases, medical research, IVF techniques, and politics made possible by individual patients. But it also about stem cells making connections between time-frames that were earlier kept apart: the present and the future. The cases of Reagan, Reeve and Fox shows a direct connection between past and future: The connection between the presently sick and the donors to be, create oppositions between entities that were never opposed or even connected before: suddenly one has to decide: Which is the greater ethical offence - sacrificing the dying to protect the unborn? Or sacrificing the unborn to save the dying? Are you on the side of the not yet living, or the not yet dead?

The patients are not in doubt; they bet on the living. This means among many things, that other types of capital holders step on to the money-scene. In the example of beta cells, for example, an important financial player is the Juvenile Diabetes Research Foundation. The foundation is funded by private citizens – some of whom happen to be tremendously rich – who have themselves developed diabetes, or have had family-members do so. The laboratory leader working with diabetes presents them in this way:

> They are incredibly influential, and they use NIH's[11] peer review system, plus that they have their own experts among laypeople, who make the final evaluation on top of the scientific

[8] On October 11th, Christopher Reeve, best known for his part as Superman, died after being paralyzed for many years. Reeve was paralyzed after a riding-accident, and it was believed that his neural damage could only be repaired through future stem cell therapy.
[9] Michael J. Fox suffers from Parkinson's disease, a neural disease, that – like Alzheimer's – has no cure today, but which is expected in the future to be curable by means of stem cell therapy.
[10] The American struggle over embryonic stem cells dose not stop with the presidential election of 2004. Thus, in May 2005, the American Congress voted in favor of expanding federal funding for stem cell research.
[11] National Institutes of Health (an agency of the U.S. Department of Health and Human Service)

> evaluation. Thereby they set the agenda of what they really want to use the money for themselves. (Interview, april 2005)

Thus we have a scenario, were it is an important future determinant which patients have more money. And patient-associations is by far more willing to invest money than the venture capitalists. At the same time, the competition between different groups of patients makes the general feeling towards research restless and fickle. People are dying; we want to see results NOW. When one promise of a momentous breakthrough is not followed quickly by an actual cure, the collective attention is turned on other promises and other futures.

Patients are both the innocent victims of diseases, industry and research and increasingly taking demand of the situation, both by influencing policy and by financing research. The influence they wield are focused around specific deaths and specific diseases. The future projected for all of us – of death and disease – is implicated here. Importantly, the death and disease that awaits us all is not *one* future. We all have our individual deaths and our individual diseases. It could be seen as a multiple future – more than one (meaning not the same disease) but less than many (meaning the same effect; dying) In discussing which disease is most worthy of research funds, the patient associations pluralize this future. The different futures start competing fiercely for attention and money, and choosing which future death to focus on becomes a very hot topic, that influences which reality lies ahead of stem cells profoundly.

Path 5: Fiction

An important factor in the much commented *hype* that surrounds all kinds of biotechnology, and embryonic stem cells especially, are retrospected prospects - the futures projected from the past into present - often in much appealing guise of literature, movies and myths. These are important factors in explaining why some phenomena are recognized as *really* being the future – and hence worth noticing, debating and supporting or rejecting. You hear about some *futuristic* phenomenon, and immediately know; yes, this *is* the future. Wordplay on "Science Fiction" and "Science Faction" is widespread in the rhetoric surrounding embryonic stem cells. It is on this path that I find a tentative answer to why so many think that stem cell therapy and industry is "more real" than I have found it to be.

Fictional tales of the future are abundant, and many of them have to do with eliminating in some way our connection to biology, and letting go of the connection between biology and destiny. Cutting the connection between biology and destiny leads either to dystopic or utopic tales. Below I will sketch out some of the stories that I believe to be among the important ones, living in the "public unconscious", sketching out paths that come to seem unavoidable. In other words; this section deals with path dependency and path creation like the other paths I have described – only the paths described here are not practical, but fictional, from all kinds of

cultures, times and ages. This, however, does not mean that they are without practical effects. Here are a few examples:

In the ancient Jewish tale of the **Golem**, a rabbi – rabbi Loew - creates a giant creature of clay – a Golem – to help the poor, Jewish people of Prague with their daily chores. After some time, the Golem realizes that there is more to life than working. It starts wanting to be like children and play like children. Rabbi Loew tells the Golem that this cannot be. The Golem goes into a rage, and throws rocks. The people chase the Golem, but it manages to flee Prague, never to be seen again.

Mary Shelley's ***Frankenstein*** (1831) is built on the basis of the Golem-myth: Young dr. Frankenstein builds a creature of body parts from corpses, and gives it life by leading the electric current of a lightning storm through it. The creature lives, and has a kind heart, but is hideous, and frightens everybody. As dr. Frankenstein denies the creature love and thereby humanity, it becomes violent and is killed.

Aldous Huxley´s ***Brave New World*** (1932) takes place in a future, in which people are divided into 5 sub-groups; the Alphas, and Betas rule the system, while the work-force consists of Gammas Deltas and Epsilons. Each of these groups are specially designed to serve special purposes. Unhappiness and disease has been removed from the system by means pre- and postnatal conditioning (genetic engineering and hypnosis) and use of a drug called soma. The system is challenged by an outsider – John the Savage from the Reservation – who reclaims mankind's ills and evils. In other words; the right to be unhappy. He ends up committing suicide.

In Ridley Scott's movie ***Blade Runner*** (1982), based on Philip K. Dick's short story, ***Do Androids Dream of Electric Sheep*** (1968) humans have created "replicants", that serve the humans in various ways – mainly as soldiers and prostitutes on the off-planet colonies. The replicants are created with a termination date (usually marking a life-span of 4 years), to avoid them getting out of control. Four replicants escape and go to earth to find their master and creator, to persuade or force him to change their termination date. They are killed in the process.

These tales are just a few examples of archetypal tales about humans meddling with Creation, severing the connection between biology and destiny. It is also about the unavoidable punishment that follows when that which is created stops being a creation, a thing, and starts being a self, human or otherwise. This mythical tale is so widespread, that it forges out a path, that almost everyone can recognize: We are meddling with Creation; we will be punished. This is probably one of the reasons why biotechnology has such an ability to attract public attention and connect forcefully with the media. It is probably also a reason why attending to the human/thing divide becomes a major concern in the public debate and the media. We all know

that this *is* the future, and that we *will* be punished for it. It is also an important litmus test for projected futures put forth by different actors; is the future reminiscent of The Future, or is it not? In other words, when assessing the images of the Future presented in these works, the relevant question is not (only) whether they are "right" or not. Whether their conception of the future become true may not be the most relevant question to ask, although it is the one that is most often asked. Rather, one should ask how they worked in shaping present reality, and how they will continue to do be factors in shaping the future reality.

I believe that these fictional projected futures are a substantial reason to why one type of network, i.e. is a discursive, policy-based network is stabilized. This stabilization takes place in the name of medical, therapeutic and research practice. This practice, however, is much more real as a potential than as a real-time practice. The fictional tales sharpen the focus on (potential) practices that might have similarities in common with these tales, thus stabilizing the present networks, while at the same time projecting the idea that it is laboratory practice that does the stabilizing.

Conclusion

Why is it that laws, regulations and discourses change to facilitate the realization of stem cell therapies and products, but that commercial practice does not follow? Why do the frames constantly overflow? What are the problems connected to framing a multiple object? These were the questions I asked in beginning of this paper.

I have mentioned five paths leading to the stem cell – and leading it into the future: The cell, the egg, the money, the patients and the fiction. Regarding the embryonic stem cell as being simultaneously on different *paths*, also means that the use of Karnøe and Garud´s concept is rather illoyal. I have not described institutional, technological and social factors as constituting one coherent national path. Rather, I have seen the different actors as being on five paths constituting a vast and complicated web of interconnected future projections. What I have adopted from Karnøe and Garud is the idea that the part of the path already travelled to some extend decides the direction of the path lying ahead:

In the case of the cell, the potential futures are *legio* – and that is of course the point: the stem cell can become anyone of the human body's cells. However, important obstacles stand between the stem cell and its omnipotent future; for instance, the ability of researchers to make stem cells develop into the cell the researchers want them to; the making of enough stem cell lines to cover the tissue types of the entire human population of the earth; The ability of the researchers to suppress the stem cell's contested tendency to divide uncontrollably after being transplanted into the patient's body, thus becoming a new form of cancer; and the ability of

researchers to cleanse stem cell lines of animal protein, which would make a patient's body reject the stem cells transplanted to it. The reality of the cell as clinical, therapeutic and marketable product depends to a large degree on the researcher's ability to overcome the many obstacles laid out by the cell.

In the case of the egg, one overwhelmingly dominant future is projected ahead of it: becoming a child. The future of the egg projected by stem cell researchers, is the one of becoming a research subject, and possibly a stem cell line used in laboratories throughout the world, potentially saving many lives. Here, the battle of projected futures is between becoming a child and becoming a cure – maybe *the* central battle in the stories of stem cell research.

In the case of the money, the futures projected by present venture capitalists are futures of earning safe money at short time spans. The venture capitalists have learned lessons by retrospecting prospects, especially of the Human Genome Project and Biotech-bubble, but also of the financially more disastrous IT-bubble. The lesson is this; do not believe what they tell you about heroic futures; make the safe bet. This projected future is incompatible with the future projected by science; if we invest much money for many, many years we just might get a cure. This has a place in the network standing open in the network – the place of the money. This open place gives much power and influence to another groups of actors - the patients.

The patients is one of the most important reasons why embryonic stem cells is projected powerfully into the future in spite of the egg's tendency to follow the path of the child: The patients, their diseases, and their wishes for cures, is a strong factor in projecting stem cell therapy into the future – in the face of the financial risks, the technological problems, the critical and scarce resource of the eggs, the cells' biological tendency to develop into things that it shouldn't become. It is hard to deny the sufferings of patients with Alzheimer's, Parkinson's, diabetes, etc., and to wish for a cure. It is hard to deny the fear in us all, that one day it might happen to me or my children; and by then they better have found that cure. Moreover, patients' associations are becoming important players in shaping research initiatives, as they hold funds for research, but withhold the right to influence what shape and direction research should take.

Lastly, fiction projects important futures. The future projected by fiction tells us that the day will come when we control biology. It also tells us, that when this day comes, we will be punished. Thus we all know that it will indeed happen, and that it probably shouldn't. This ability to recognize futures as relevant and as dangerous is important in shaping the paths of the embryonic stem cells, as it shadows the fact that the discursive policy-reality that is, is not the same as the practical therapeutic reality we are talking about.

This recognition of relevant futures nurtured by fiction, combined with the extreme connectivity of the stem cell makes it almost impossible to frame it and cool the surrounding situation. On the one hand, the researchers – especially from commercial labs – insist that the only prob-

lem is the lack of money. This insistence denies the complexity of fiction, babies, patients, etc. The conceptions of stem cell futures – many as they are – end up competing.

Does this mean that any attempt to frame the embryonic stem cell is and always will be futile? Hardly. Already, many stem cell framings exist. On each path I have described, the stem cell is framed as something specific – as discursive objects, future babies, myths… However, none of these frames equals "present, therapeutic product", although this is the common point of reference. Thus, the existing frames are all second order frames, so to speak. Over the next years, we will probably witness struggles over the right to define the "right" frame. But even though this quarrel will continue, it will be exceptionally difficult to settle the fight when discussing embryonic stem cells - because of their innate "transness". Embryonic stem cells are equally research-subject, product, therapeutic medicine, myth, people, eggs, and much else. The embryonic stem cell is a tiny object with the capacity to link many networks that was previously unlinked - a tiny object able to take on many shapes. Framing it as singular will be extremely difficult.

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