After the 'two cultures': Towards a '(multi)cultural' practice of science communication.

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Introduction

When C.P. Snow—scientist, novelist en public figure—held the annual Reed lecture in 1959, he launched a simple conceptual framework that would structure academic consciousness and influence our thinking on the status and position of science for most of the twentieth century. In *The Two Cultures*, Snow identified a substantial gap between two branches of knowledge: the (natural) sciences and the humanities.[2] He described them as two separate and even hostile cultures who live in different worlds and who don't speak the same language. Arguing from a profoundly humanist point of view, Snow associated science and technology as the basic conditions for democracy and modernization—a western standard of civilization. A standard, however, that was threatened by a Great Divide, manifesting itself in mutual scorn of rivaling academic disciplines. Its underlying hierarchy had substantial repercussions for an educational system (and society) that structurally understated the importance of scientific literacy. I think it is instructive to trace how some of his conclusions still inform contemporary ideas about knowledge construction and dissemination. Snow's metaphors of a sharply divided academic landscape and an almost unbridgeable gap gave rise to debates about poor scientific education and a lack of interest to communicate science to a general public. In the 1960s, newly developing theories on the public understanding of science (PUS) explicitly hinged on Snow's perceived gap between science and humanities, as well as on a perceived divide between a knowledgeable group of scientific experts and an ignorant public, poorly trained in the facts and minimally interested in the effects of science and technology.

In this paper, I will argue how Snow's bipolar modernist concept no longer applies to a contemporary situation; social, intellectual and institutional transformations have radically changed the academic landscape since Snow's pretentious framework triggered both public acclaim and outrage in 1959. In addition, traditional public

understanding of science approaches seem inadequate to account for contemporary interaction between scientists and nonscientists, to explain what used to be called the 'dissemination of scientific knowledge'. Despite its powerful echoes, PUS has recently been complemented by postmodern approaches, resulting in what I will call a '(multi)cultural' practice of science communication. Such paradigm not only acknowledges the increasing cultural diversity in scientific and academic populations throughout the world, but also claims many disciplines and professions to be simultaneously involved in the construction and negotiation of science. This emerging postmodern concept of science communication, as of yet undertheorized, deserves to be explored in more detail.

After the two cultures

Snow recounts how, before 1800, all scholars operated under the aegis of philosophy, until the industrial and scientific revolutions caused a distinguished class of 'scientists' to come into existence. The actual two cultures divide dates back to the 19th century, or more precisely, to the 1830s when the term 'scientist' was coined analogous with 'artist'. A split in educational degrees (Bachelor/Master of Arts vs Bachelor/Master of Science) led to a subsequent split in professional socialization—a division of tasks where ethics, aesthetics, history and culture became the domain of one group of scholars, whereas another group was exclusively concerned with understanding and controlling the laws of nature. As Snow stated in 1959: "I believe the intellectual life of the whole of western society is increasingly being split into two polar groups "(3). Polarity and mutual ignorance led to reciprocal scorn: a profound inability to understand each others disciplinary discourse resulted in a disdain for the other's concerns. According to Snow, increasing animosity between the two academic communities had turned literary intellectuals into natural Luddites—ignorant and thus deeply distrustful of science and technology. Scientists, on the other hand, disregarded the basic values ingrained in humanistic knowledge, hence rejecting their relevance out of hand. This simple binary model led Snow to despair about the ability of these two groups of scholars to ever speak the same language again.

In a later revision of his lecture, Snow conceded his omission of a 'third culture' in academic communities: social historians took a position that he had not previously acknowledged. In fact, Snow, even in the latest refinement of his lecture, understated the emergence of an entire class of social scientists, economists and other disciplines whose presence on campuses worldwide was about to explode. New groups of scholars did not leave science to the scientists, nor did they accept a total absence of humanist values in the scientific domain. Social studies of science and technology was only one of many new disciplines that sharply criticized the purifying practice of modern scientific thinking, demolishing not only the walls between communities of scholars but rethinking the constitution of modernity itself.[3] Rather than becoming Luddites, many humanities scholars (from philosophers to literary scholars) together with scientists (from biologists to medical scientists) transgressed their disciplinary barriers to become actively engaged in reconstituting the Great Divide.[4]

In addition, Snow did not or could not foresee the rapid explosion of hybrid fields that crushed his categorization into sciences and humanities as well as his further division of the science field into pure and applied science. Since the late 1950s, a broad palette of new disciplines has blurred the bipolar scheme that once characterized the academic architecture: disciplines like molecular biology or bio-engineering, or new fields like artificial intelligence or computer science, can no longer be categorized in any one of these polar extremes, as they require an aptitude to think across boundaries. New hybrid disciplines emerged, subverting the implicit hierarchy within the sciences. After the 1960s, the 'polar extremes' of (applied and pure) sciences and humanities rapidly transformed into a heterogeneous field of subdisciplines and interdisciplines, whose claims also pertained to educational structures, social attitudes and policymaking. Jean-Francois Lyotard, in 1979 concluded that "…the status of knowledge is altered as societies enter what is known as the postindustrial age and cultures enter what is known as the postmodern age" (3).[5] The 'postmodern condition' of science, as Lyotard called this, was the result of a splintering of discourses and the narrativation of knowledge. Construction and dissemination of knowledge can no longer be separated in a postmodern society, challenging the very meaning of the concept of 'knowledge'. Walls between academic communities, since Snow's lecture, have become increasingly porous and many

of us evidently enjoy the boundary crossings that were still unimaginable in 1959. Rather than speaking of two communities, the global village of academic cultures consists of many hybrid categories, challenging disciplinary distinctions and disputing the very constitution of scientific knowledge.

Arts and sciences, according to Snow, were strictly separate domains in 1959; he lamented the fact that, except for an occasional poet conscientiously using scientific expressions, "little of twentieth-century science has been assimilated into twentieth-century art "(16). Ignoring famous popular science writers before his time, such as Aldous Huxley and H.G. Wells, Snow obviously had a very strict idea of what assimilation of science in art should entail. The literary qualities of nineteenth-century biologists like Julian Huxley or Charles Darwin laid groundwork for later artists who considered science to be part and parcel of their mental experience. The narrativation of science, identified by Lyotard, obviously pertains to the discursive structure of scientific knowledge. Yet the opposite movement, what I woul call a 'scientification of artistic expression' can also be noticed in the past forty years.[6] Apart from a full-blown literary genre (the science novel and science fiction film), we have now innumerable areas of artistic expression—sculpting, video-installation, painting, performance—that take science or technology as its central focus.[7] Installation artists like Mona Hatoum, anatomists-sculptors like Gunther von Hagens, or installation artist like Nell Tenhaaf almost permanently draw attention to the artistic, social and cultural aspects of science and technology.[8] DNA-installations or plastinated anatomical sculptures prominently figure in our national galleries and exhibition spaces. Besides many artists using scientific material (such as DNA or endoscopic images) there are a growing number of scientists who draw attention to the aesthetic qualities of scientific results while inventing new technologies, for instance medical photographers like Lennart Nilsson. In other words, the gap between artists and scientists is continually traversed in both ways, and the two-way traffic renders boundaries increasingly obsolete.

Implied in Snow's argument of 'bridging the gap' between arts and sciences, was the dire need to translate between expert and lay communities. He transferred the 'two cultures' paradigm from an academic onto a non-academic context: Snow concluded that many people were deprived of the most basic education in science. His concern for

scientific illiteracy and unbridgeable gaps was not restricted to academic communities of arts and humanities scholars but was in effect a much broader concern. Part of the problem he diagnosed was the early specialization in education, which in England already started in secondary schools and made children decide at an early age in which area to specialize. Snow advocated that the longer kids would speak each other's language in school, the more chance of constructive dialogue between scientists and non-scientists in their later professional lives.[9] As long as education failed to provide such needs, a professional group of translators was needed to mediate between the specialized lingo of scientists and a lay audience of virtual scientific illiterates. Science journalists, teachers and popular science writers were called upon to fix the knowledge deficit. Most western countries established associations for science writers and journalists, created subsidized centers for scientific education, stimulated the founding of science museums or educational programs for children. In short, the gap between scientists and non-scientists created a whole new government and industry-supported branch of 'translation.'

After the Public Understanding of Science

In academia, an entire field, known as 'public understanding of science' (PUS) emerged on the basis of Snow's modernist assumptions. For almost fifty years, the 'two-cultures' paradigm has informed the research in science communication, and still does to a large extent. Yet how have paradigms of public understanding of science adjusted to the changes of the postmodern condition? A recent article by Mike Michael in *Science, Technology and Human Values*, illuminates two historically dominant approaches in PUS.[10] Traditional PUS, an approach popular in the 70s and 80s, aims at measuring the deficit and subsequently bridging the gap between scientific experts and lay people.[11] Critical or interpretationist PUS charts the clash of cultures between the expert and the lay, thus acknowledging social, emotional and political aspects of science. [12] Both approaches basically depart from a deficit model: they assume a distinction between expert and lay person and hence between science and culture. Intervention for these two variants of PUS lies respectively at raising the levels of cognitive awareness and negotiating critical awareness. Mike Michael, in his article, challenges the assumption

that people are either cognitive repositories or socio-cultural recipients of scientific knowledge. Instead of emphasizing the difference between scientists and lay audience, he points at the continuity and contingency between people, things and arrangements. As Michael observes, in our contemporary techno-scientific culture, "there is no easy differentiation between the expert and the popular, between the scientific and the lay, between the factual and the fictional" (370). Like art or religion, science and technology are also expressions of society's orientation to the world, and as such they are inseparable from politics.

Michael's conceptual criticism touches the very core of the academic endeavor we call PUS. While the phrase 'understanding of science' inherently implies a hierarchical distinction between a cast of 'experts' and a cast of uninformed lay people, he proposes another concept in addition to the powerful Snowian 'bridging the gap' metaphor. Advocating a project under the name of 'hybridic prehension of rhizomes', Michael introduces concepts that account for the heterogeneity and distributedness of science; these concepts also acknowledge the fact that not two, but many actors (both human and non-human) participate in the construction and dissemination of science and technology. In theory, Michaels proposal entails a laudable adjustment of our theoretical theses to the epistemology of everyday life. He is also very careful not to do away with 'old' forms of PUS, both traditional and critical. As much as I agree with Michael's lucid analysis, I want to bring up three aspects of PUS that neither Snow—as the representative of the ultimate modernist paradigm—nor Michael—as the impersonator of the postmodernist paradigm—fully account for: the (changed) role of media, of media technologies, and the (changed) role of audiences.

As far as Snow is concerned: the absence of media in his *Two Cultures* lecture, at a time when television had just started to become a substantial presence in Western living rooms, is, to say the least, remarkable. He never once mentions this new apparatus that would potentially open up new venues for mass-education of audiences in subjects of science. As we now know, television's prime function never became that of science educator, but a medium for mass entertainment. We long regarded television, like newspapers, as tools for disseminating ideas and knowledge, yet gradually we have come to acknowledge their constitutive role in the construction of science. Looking at our

screens today, we can see how scientific knowledge is distributed through the many products the film- and television industry are creating. Blockbusters like *Artificial Intelligence*, *Gattaca*, *The Cell* or television series like *Star Trek* mix scientific knowledge with fictional techniques, attracting large crowds and moving science and technology to the limelight of public attention and debate. Although Mike Michael does mention the potential power of written science fiction as a source for contemporary PUS-research, he does not explicitly mention the audiovisual media as an important cultural arena, where scientific knowledge is not just mediated but constructed. Rather than narrowing down the scope to a small corpus of specialized science journalism, we need to recognize how the entire apparatus of audiovisual mass entertainment is more than a simple mediator: it is an important space where the construction and constitution of science is negotiated.

In 1959, Snow observed how little non-scientists were directly exposed to the products of science and technology, explaining not only their ignorance but also fuelling their basic *Angst* for technology. At best, a humanities scholar would use a typewriter in his or her office and ordinary citizens had just gotten acquainted to the moving picture box in their living rooms. These technologies were most likely their closest encounter with the marvelous worlds of science and technology, and such scarce exposure inevitably led to Luddism, as Snow assumed. Forty years after his famous lecture, science and technology, it is safe to say, have become part of the fabric of everyday life. Children start using computers at age 6, play with gameboys, handle complex audiosystems. Hardly any people live their lives without being confronted with medical engineers. Computers, scanners, cameras, medical technology, airplanes and other means of high-tech transportation are not only ubiquitously present, but our bodies have to a large extend incorporated these technologies into our basic systems. Admittedly, most people are still ignorant of the second law of thermodynamics (as Snow once complained) and most likely, few people could explain the exact problem with the hole in the ozone layer, yet the massive infusion of technological tools in our quotidian experience have profoundly changed our horizon. Ignorance coupled onto antagonism is a problematic teleology in the twenty-first century western world. Luddism, if still applicable, can hardly be the result of too little exposure to science and technology. Even people or

groups who conscientiously oppose particular scientific or technological projects, are themselves grounded in a thoroughly technologized society and often deploy its high-tech infrastructure to communicate or congregate.

The 'media', in other words, no longer mediate between experts and lay persons, but are actors in processes of construction *and* dissemination. The media, like science, is not something out there, bound to disseminate messages or expose a mass audience to experts knowledge; media is equally distributed, heterogeneous and equally implicated in the construction of science as part of culture. Mike Michael connects the inclusion of technology in everyday life to recent debates on how we have all become postmodern cyborgs: combinations of bodies and machines, flesh and electronics, at once constructed and manipulated. Science and technology, rather than being an entity outside our bodies, something out there in society, is now internalized, incorporated in our physical existence. Yet Michael fails to notice the importance of media technologies, especially in its high-tech and digital form, have become an inextricable part of the socio-technical ensemble.

This brings me to my last footnote to Michael's postmodern revision of the two cultures paradigm. Implied in Snow's metaphor of bridging the gap, and the ensuing PUS tradition, is the assumption of an audience that is at once homogeneous and passive. Knowledge of science and technology had to be infused in the ignorant masses, whose resulting enlightenment would lead to critical apprehension, if not appreciative comprehension. Michael introduces the term 'prehension' to emphasize the active participation of expert and audience in the formation of knowledge: "Prehension thus points not only to the materiality of the message but also to that of the senders and receivers: the corporeality of humans is thus incorporated into this account" (368). Though illuminating, I find the term 'prehension' too weak to define the new role of 'audience' (or consumer) in the construction of scientific knowledge. Knowledge is indeed incorporated in many different subjectivities comprising 'the audience', which heterogeneity could not be emphasized enough. Yet the assertiveness and active role of formerly considered 'cognitive expositories' manifest itself in the transformed attitude of audience into 'knowledge-seekers' or 'interpretation-demanders'. This new category of audience has access to a network of tools that fifty years ago still seemed a remote

fantasy. Doctors, for instance, are increasingly confronted with patients who have searched the internet for the latest specialist publications on their (self-)diagnosed disease. I am not arguing here that people, through the internet, have become more *knowledgeable* of particular scientific facts (note that for interpretation and judgment they are still dependent upon the specialist they consult) but what is new here is their *attitude*: patients have become co-constructors in the process of defining knowledge.

It is pointless to lament, like Snow did, the specialization of scientific knowledge, since it is the precondition of intellectual progress. It is equally fruitless, though, to lament the change in attitude that makes people active searchers for specialized knowledge even though they are probably unable to decode, value or apply it properly. The fact that they search knowledge and demand interpretation should be seen as an interesting shift in a culture where science and knowledge is no longer passively disseminated but actively negotiated. The 'audience' is a complex and heterogeneous actor in this process and as such requires a profoundly different attitude from scientists or specialist professionals. It may be helpful to emphasize another simple truth, namely that the audience does not have just *one* identity, but that we inhabit overlapping identities—social, racial, sexual, religious, intellectual and political—and no one of them alone consistently determines our responses or interactions. Just as the bipolar professional identity of scientists and artists has splintered into a kaleidoscopic range, the binary opposition between scientist and non-scientist has equally dissolved into a continuous palette of participants.

Towards a (multi)cultural practice of science communication

As much as I applaud Michael's endeavor to update the classical PUS and science communication paradigms, I would like to take his theorem one step further and explore what I call the '(multi)cultural practice of science communication'; I prefer this phrase over Michael's 'hybridic prehension of rhizomes' for several reasons. First, I would like to emphasize the word 'cultural' as the preferred focus on science: science is merely one set of cultural activities among others and, with Michael and other academics, I choose to consider science as part of culture. However, I tentatively add the prefix 'multi' in order to demonstrate the inherent multiplicity of cultures in contrast to Snow's binary 'two-

cultures' model. There are many cultures (professional, disciplinary, global, ethnic) involved in the construction of science. Analogous to Snow, the word 'culture' indicates groups of academics, yet adding the word 'multi'—the postmodern prefix *par excellence*—I underline how diverse and permeated these communities have become. Just as western cultures are now heterogeneous and diverse in their local and national contexts, scientific communities are no longer confined to their normative institutional boundaries. Many professions and disciplines who used to stand apart from science are now actively involved in it; scientists, journalists and artists are equally engaged in making sense of scientific knowledge, substituting the terms 'production' and 'dissemination' of knowledge for 'construction' and 'negotiation'. And, last but not least, science has become a global multinational and multi-ethnic enterprise, particularly since the advent of computers and the internet. The word 'multi-cultural' should thus account for these various emphases.

Secondly, my choice for the term 'practice' rather than 'knowledge' should be understood as a shift away from science as a ready-made product of a group of self-declared professionals towards an approach of science as an open-ended, negotiated and negotiable arena of meaning construction. The term 'practice', as defined for instance by Andrew Pickering, allows to regard science as "a field of powers, capacities, and performances, situated in machinic captures of material agency" (7).[13] Included in the practice of making science is the diffusion of science, as the two activities are inevitably interrelated. For instance, the press conference a biotech company organizes to promote its scientific concepts and potential patents is as much part of the construction of science as the article in *Science* describing the results of the latest genome sequencing effort. Within the practice of science, various agents play different roles: potential patients, consumers, commercial suppliers and government representatives are all involved in the construction of scientific knowledge, and so are nonhuman agents, such as computers, an electron microscope or sequencing software.

Third, I prefer the term 'science communication' over 'public understanding of science' because the latter still assumes an implicit hierarchy between experts and the ignorant. Moreover, in line with Snows argument, the phrase tacitly accepts the idea that as long as the public understands science, the knowledge deficit will be solved and the

gap will be bridged. Apart from aforementioned problems with the notion of 'public' as a homogenous recipient of knowledge, the other meaning of public (as 'open to all persons') is not simply a fact, but is often at stake in contemporary negotiations of scientific knowledge. At least 'science communication' implies reciprocity between all agents involved, a feature basic to a cultural practice. The public is always involved in the practice of science, whether conscious or unconscious: the mediation of science by internet, print or television renders knowledge available and negotiable.

More important than defining what a '(multi)cultural practice of science communication' entails, is describing what such paradigm makes possible in terms of actual tools and academic approaches. In other words: what are the consequences of a postmodern paradigm for the *communication of science*, and what does it mean for *academic study of science communication*?[14] Let me give two examples to illustrate the implications of this proposed paradigm for both communication of science and technology and for the academic study of science communication.

The *communication of science* traditionally took place in educational settings: schools and museums, where passive consumption of knowledge was a dominant mode of learning. In past decades we have seen the emergence of science centers (often alongside the old fashioned science museums) as sites promoting active participation and interactive engagement. Science centers epitomize a more general trend, manifesting itself both inside and outside institutional contexts, toward involving the consumer in the dialogue revolving around science and technology. An example worth mentioning in this respect is the work of Natalie Jeremijenko, a mechanical engineer at Yale University who shows how science and engineering can raise critical, aesthetic, political and cultural awareness in users. Users of technological equipment designed by the Yale artist-engineer are never passive observers but always active participants in the construction of knowledge. One of Jeremijenko's projects, assigned by the Bureau of Inverse technology in San Francisco, is called 'Sperm Economy'. It is an installation of spermboxes to which visitors can contribute sperm and see how it results in a 'sperm-economy' of genetic mixes.[15] The result of this installation is a kind of do-it-yourself, primitive genetic engineering experiment, which demonstrates and yet questions the ability to 'choose' your own off-spring. Another example worth mentioning is Jerimijenko's project to

design environmental pollution meters: small boxes that can be coupled onto a personal computer to measure oxygen and pollution levels in a certain environment. Devices like these render people aware of what effects environmental pollution on a small scale, informing them how to adjust environmental factors to make the air healthier and cleaner. Jerimijenko's projects are neither art nor science, nor even simple technological gadgets; they are very effective practices to communicate scientific knowledge; her 'pollution boxes' or 'sperm banks' are both useable objects and political statements, both tools for awareness and instruments enabling interaction and intervention. These are the kind of tools that involve people in science as a cultural (and even multicultural) experience.

My second example concerns the consequences of the (multi)cultural paradigm for the *academic study of science communication*. Science, as I said before, is negotiated in many cultural arenas, from the laboratory to science fiction. Therefore, if we think of sites were scientific and technological knowledge is shaped for a general audience, we should no longer attend uniquely to the science section of the *New York Times*, but also look at *National Geographic* channel or big Hollywood productions. In the past, popular entertainment has been regarded primarily as a vehicle for promoting scientific knowledge: medical documentaries or drama series, for instance, were supposed to convey specific scientific facts packaged in appealing narratives.[16] Yet rather than focusing upon 'the popularization of science through the media'—an approach in which the media are viewed as means to fix the knowledge deficit[17]—I would propose to regard at the entire spectrum of sites (including laboratories and hospitals but also texts, images and moving images) of a particular scientific field as a focus for investigation.[18] Such research includes for instance, in the case of medically oriented research, television series and hospitals equally as sites of cultural-scientific negotiation or construction. Series like *ER* are scripted using substantial input from medical specialists and industries; some episodes incorporate the latest medical research or promote cutting-edge treatments or techniques. Interwoven in these intricate narrative explorations of medical knowledge are ethical, social and economic dimensions of medicine. On the other end of the spectrum, episodes of *ER* are used in teaching hospitals and educational settings to train nurses and other (para)medical professionals in diagnostic skills.[19] What is important in this example is that both television series and medical hospitals are considered part of a cultural

practice where knowledge is negotiated. More than narrative or discourse, the cultural practice of science takes place at many sites—physical, institutional, discursive—that interact at the level of meaning construction.

By proposing a '(multi)cultural practice of science communication' I am not dismissing (traditional or critical) paradigms advocated by PUS-scholars. Needless to say, these approaches still have an important strategic and political agenda. As Mike Michael states, a postmodern, heterogeneous approach to science communication in many ways complements existing PUS approaches.[20] In sketching the transformation from Snow's 'two cultures' to Michael's 'hybridic prehension of rhizomes' I have tried to outline the historical changes in both the academic landscape as well as the academic studies of science communication. These two transformations are inextricably linked and should always be considered in tandem. By sketching the various lines of research that have dominated the field in the past half century, and by giving specific examples of the implications of a postmodern reorientation for the practice and theory of science communication, I hope to contribute to an important and exciting scholarly discussion that, in my view, has only just begun.

NOTES

[1] I would like to thank the Dutch Association for the Public Communication of Science (Stichting WeTeN) in Utrecht for making this paper possible and for their generous funding.

[2] C.P.Snow, *The Two Cultures*. Cambridge: Cambridge University Press, 1993 (Canto edition, with an introduction by Stefan Collini). Orig. published 1959.

[3] Bruno Latour's *We Have never been Modern* (Cambridge: Harvard University Press, 1993) is considered the epitome of this discussion.

[4] Among these scholars, I count, besides Bruno Latour, Donna Haraway, Andrew Pickering, Jeffrey Alexander and others.

[5] Jean-Francois Lyotard, *The Postmodern Condition: A Report on Knowledge*. Manchester: Manchester University Press 1984. (orig published in French, 1979)

[6] For a more elaborate approach of science as discourse or narrative, see Joseph Rouse, "What are the Cultural of Scientific Knowledge?" in: *Configurations* 1 (1992): 1-22. Scott Montgomery, *The Scientific Voice*. New York: The Guilford Press, 1996. Greg Meyers, *Writing Biology. Texts in the Social Construction of Knowledge*. Madison: University of Wisconsin Press, 1990.

[7] For a discussion of relevant art works in the area of genetics, see José van Dijck, *ImagEnation. Popular Images of Genetics*. New York: New York university Press, 1998.

[8] On Nell Tenhaaf, see Van Dijck, *Imagination*, chapter 6. On Gunther von Hagens plastinated body-sculptures, see Jose van Dijck, 'Bodyworlds: The Art of Plastinated Cadavers' in: *Configurations* 9: 1 (2001) pp. 99-126.

[9] CP Snow diagnosed the British educational system to be worse than the American and Russian systems in this respect: at least they did not allow their pupils to specialize at an early age.

[10] Mike Michael, "Comprehension, Apprehension, Prehension: heterogeneity and the Public understanding of Science, in: *Science, Technology and Humand Values* 27:3 (2002): 357-78.

[11] Representatives of the traditional PUS-approach include: John Durant, J. Gregory and S. Miller, Stephen Hilgartner, and others.

[12] The paradigmatic exemplar of critical or interpretationist PUS is Brian Wynne.

[13] Andrew Pickering, *The Mangle of Practice. Time, Agency and Science*. Chicago: Chicago University Press, 1995.

[14] Naturally, I would like to avoid the use of the term 'communication of science' as if it were a separate category, apart from the cultural practice of science.

[15] Various men were asked to donate their sperm to an extensive sperm bank installed at Blasthaus, an alternative art space in San Francisco. The sperm were then categorized and sorted by the same categories used by the California cryobank, including race, hair color, eye color, and height. The bureau also added economic categories such as consumption behavior and market demographics. The sperm were stored and publicly displayed in nitrogen-cooled vats. It was then possible to order a kind of sperm cocktail which would include specific characteristics of various men so as to increase one's chances

of producing the desirable offspring. These cocktails or 'democracies' as they were called, were then sold off as anonymous human sperm during a live auction.

[16] See, for instance, Leah A. Lievrouw, 'Communication and the social representation of scientific knowledge' in: *Critical Studies of Mass Communication* 7:1 (1990) 1-10. Terry Shinn and Richard Whitley, *Expository Science: Forms and Functions of Popularizations*. Dordrecht: Reidel, 1985. Specifically with regard to medical television series, these types of research often interrogate the realistic content of medical television. See for instance, Gordon, P., S. Williamson and P. Lawler (1998) 'As Seen on TV: Observational Study of Cardiopulmonary Resuscitation in British Television medical dramas.' In: *British Medical Journal* 317, pp. 780-83 and Catherine Belling (1998) 'Reading The Operation: Television, Realism and the Possession of Medical Knowledge' *Literature and Medicine* 17: 1, pp. 1-23

[17] Bouwman, Martine, Loes Maas en Gerjo Kok (1998) 'Health Education in television entertainment—Medisch Centrum West: A Dutch drama serial.' In: *Health Education Research* 13: 4, pp. 503-18.

[18] An example of this type of research is illustrated in my book *ImagEnation. Popular Images of Genetics*. New York: New York University Press, 1998.

[19] Ostbye, Truls, Bill Miller and Heather Keller (1997) 'Throw that epidemiologist out of the emergency room! Using the television series ER as a vehicle for teaching methodologists about medical issues' in: *Journal for Clinical Epidemiology* 50: 10, pp. 1183-86. See also Turow, J. (1996) "Television entertainment and the US healthcare debate" in: *Lancet* 347:12, pp. 40-43.

[20] See Michael, p. 374.