Mapping Interdsciplinarity
Report of the survey element of the project
'Interdisciplinarity and Society: A Critical Comparative Study'
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Gisa Weszkalnys,
Oxford University Centre for the Environment
South Parks Road
University of Oxford
Oxford OX1 3QY
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1. Introduction

Interdisciplinarity has long been an element of scientific research (Whitley 1984). However, more recently, interdisciplinary collaboration has been ascribed with increasing significance. In the context of both public policy and corporate research, interdisciplinarity is frequently associated with innovation and with a particular ability to connect science and technology to potential and actual users (cf. Woolgar 1991). In other words, interdisciplinarity is claimed to play a critical role in transforming the relations between science and society (Fuller 1993, Wallerstein 1996, Nowotny et al 2001, DTI 2001, NSF n.d.). Helga Nowotny and her collaborators suggest that the recent growth of interest in interdisciplinary research reflects a broader shift from so-called Mode-1 science to Mode-2 knowledge production (Nowotny et al 2001: 15; see also Gibbons et al. 1994; Nowotny 2003). The latter is said to include:

- the development of novel forms of quality control which undermine disciplinary forms of evaluation;
- the displacement of a 'culture of scientific autonomy' by a 'culture of accountability';
- the growing importance of the 'context of application' as a site for research;
- a growing diversity of sites at which knowledge is produced; and
- the growth of so-called transdisciplinary research which, unlike interdisciplinary research, is not derived from pre-existing disciplines.

Despite the prominence of interdisciplinarity in discourses on the future of scientific and technological research, there has been little empirical investigation into this type of research practice. This research project "Interdisciplinarity and Society: A Critical Comparative Study" (Principal Investigators: Dr Andrew Barry, Prof Georgina Born, Prof Marilyn Strathern) was funded by the ESRC *Science in Society* Programme, and aimed to provide an account of the different types of interdisciplinarity existing in different research fields that bring together researchers across the natural-social science/arts divide. In particular, the project examined the ways in which public concerns, interests and demands are represented and managed in such collaborations, and to offer a critical assessment of how public concerns, knowledge and demands figure in interdisciplinary research in practice. This included, on the one hand, an analysis of different types of interdisciplinarity in terms of their forms of engagement with society; and, on the other hand, a series of empirical case studies, which were analysed as situated within broader institutional, political, and historical contexts.

The survey discussed in this paper aimed at mapping the different forms taken by interdisciplinary collaborations across a range of different research areas and across both public and private research sites. The survey drew on Internet based research, semi-structured interviews (primarily with research administrators), and participant observation at conferences and other relevant events. The snowball technique, conventionally used in the social sciences, was adapted for the Internet-based research. Institutional websites were traced, for example, through search engines, references at conferences and in interviews, and cross-linking of institutional websites. The software tool Issuecrawler (www.govcom.org; Rogers 2004) was used for its potential in aiding the mapping of interdisciplinary fields on the web. The subsequent analysis of institutional websites included both content analysis – on basic institutional facts, funding sources, research themes, and the like – as well as discourse analysis, drawing out the key modes in which institutional bodies make explicit and validate their interdisciplinary rationale.

On the basis of the initial mapping, three areas of interdisciplinary research were identified that appeared to be particularly rich and to merit in-depth analysis. These areas are science-art, environmental research (specifically climate change research), and ethnography in the IT sector. These will be discussed in detail below. Other research areas that appeared significant included nanotechnology, neurosciences, and bioethics. Overall, the survey helped in identifying key modes of interdisciplinarity, understood here in terms of: 1) disciplines involved and discourses of interdisciplinarity employed; 2) policy context and research strategy;

3) funding basis and institutional locations; 4) representation of social groups and public interests; 5) governance arrangements; and 6) outputs and dissemination practices.

2. Reflections on Internet-based Research in the Social Sciences

The survey aimed to be comprehensive both in terms of the (inter)disciplines covered and in its geographical reach. For this purpose, the worldwide web appeared to offer an effective tool. At the start of the survey, the Research Fellow had an everyday operational knowledge of the Internet, from previous research. She subsequently acquainted herself with some web-searching techniques in an attempt to gain some control over this medium that is often characterised as messy and opaque. Different techniques were used for the searches, including the search for institutions named by informants in interviews and the following of links through websites, and what Marres and Rogers (1999) term rubbing and tracing. Another tool used for the survey was the Issuecrawler, a specialist software that allows a crawling of links between websites. The survey was intended to be, to the extent that this was possible, systematic and reflective on the techniques and the assumptions involved.

2.1 Ethnographies in and of the Web

The Internet which has only recently become a part of people's everyday life, at least in the western world, has been understood through a number of both interrelated and contradictory metaphors, including revolution, evolution, salvation, progress, universalism (Wyatt 2000). Other key notions used in reference to the www are opacity and novelty. The difficulties for researchers, which come with the continuous "novelty" and rapidly changing nature of the WWW, also put constraints on this survey. Websites could be altered, be put on the web or taken down without the researcher being able to follow or even notice these changes. Nonetheless, this project was interested less in the Internet as a "new" or 'emergent form of life' (Fischer

2004; cf. Abbate 1999) than in the ways in which it offered a glimpse on social/institutional life as it exists outside or beyond the web. At the same time, the Internet could not be taken simply as a reflection of what institutions exist and how they are related to each other on all levels.

Social theorists, such as Manuel Castells (1989), have offered generalised accounts noting the peculiar disembodied and placeless nature of 'cyberspace' and the 'Information Society'. By contrast, anthropologists have emphasised how ICTs may contribute to the formation of localised and embodied identities and new (post)national spaces (e.g., Escobar 1999; Miller and Slater 2000; Sundén 2003; Ulimonen 2001; Woolgar 2002). However, the conclusion that what is happening in cyberspace can simply be reduced to social life "outside" is problematic (Hart 2004). Instead, we need to be able to account for the dialectic between the virtual and the social world – if these can be considered distinct at all. One aspect of integrating this Internet-based survey in the research overall was to critically engage with these apparently incongruous understandings of the Internet as either a 'place apart' or as simply an extension of social life. Instead of viewing Internet technology, social process and urban space as pre-given domains, we need to consider their mutual constitution and reification.

As they are place-based, electronic networks are also considered to give rise to new forms of political association around certain issues, often but not necessarily linked to concrete places. Discussion forums on the Internet are now well known and widely used, and similar techniques have been deployed and developed for political processes (e-participation). Although there are considerable limitations which may make the Internet a poor forum for discussion (Fischer 2004: 283), the general consensus seems to be that it has opened up new possibilities for political involvement. This observation may be extended to the growing field of science in/and society activities. For example, www.nanologue.net was a to provide a forum for a Europe-wide dialogue on the social, ethical and legal impacts of nanotechnology, and the website of the UK Committee for radioactive waste management (www.corwm.org.uk) allows people "to have a say" and to co-design a way forward (see also Barry 2001, on interactivity). An interesting question that is perhaps beyond the scope of the survey research is to what extent the Internet is part of the current re-thinking of the relationship between science and society. Could the Internet as a technology therefore be considered constitutive of the phenomenon of interdisciplinarity (beyond its function as a forum for institutional websites)?

2.2 Experiments with the Issuecrawler

The Issuecrawler software was invented by Dutch researchers (Rogers 2004) to aid the assessment of 'issues' on the web. Without going into technical detail, the Issuecrawler works in a deceptively simple way: the researcher simply provides certain starting points by pasting text containing urls into the Issuecrawler harvester which strips away the text and leaves the urls. From there the crawl proceeds by searching through the given websites at various (specified) depths and following all links to other websites, and so on. Overall the 19 crawls were run between September and October 2005.

The first series of experiments with the Issuecrawler was in the field of Science/Art – though the results prompted the Research Fellow to question whether it was possible to speak of a 'field' at all. The following crawls were run:

- Science/Art Institutions 1 using one European (Ars Electronica), one American (CRCA) and one Australian (SymbioticA) Science/Art institution as privileged starting points (but they were not included). The crawl depth was 2 and the number of iterations was 2. This crawl did not yield a network.
- Science/Art Institutions 2 on 23 September 2005 used the same institutions as above but the crawl depth was changed to 3 and iterations to 1. Again, no substantial network appeared.
- In parallel a crawl Science/Art Resource Sites 1 (23 September 2005) was run using three sites that I identified as science-art resource sites listing a large number of science art projects (Asci, the

science-art part of Unesco's Digiarts site, and the site of Stephen Wilson). I retained the recommended specifications. Again, no result was achieved.

- Science/Art Resource Sites 2 later on 23 September 2005 used the same starting points but had a changed crawl depth of 3 and iteration of 1. Although a network seemed to have crystallised it wasn't varied enough to be translated into a diagram.

A fifth crawl Science/Art Links Pages 1 used, similar to the above, starting points that were links pages assembling a large number of links to science-technology arts related websites (the members' links list of MIT journal Leonardo, Wilson's links site, and the links page of Susan Schuppli). Finally, a picture emerged which is focused around digital and new media arts institutions.

The apparently failed experiments with the Issuecrawler software were used productively to think through the nature of web activity and the relation between social and virtual space. The problem is how to interpret the network maps (or lack thereof) produced by the Issuecrawler without falling back onto the simplistic notion that the web – and specifically linking activity on the web – reflects social life (Rogers 2004). For example, it could be proposed that the absence of any significant network in the science-art sector reflects a refusal on the part of actors to 'link up' or, more daringly, the familiar notion of the artist as an independent individual and lone producer of unique works. It could also be related to the relative infancy of the field. However, such interpretation is in danger of conflating 'social' activities with 'webby' ones, and social with webby understandings.

The eight subsequent crawls on 'environment' and 'climate change' were more less constricted to yield potentially interesting results. They started with 'Environment UK1' (including three UK academic institutions as staring points); 'Climate Change 1' (with three UK and German Climate Change institutions as starting points); Environment intern. 1 (with three – or four – international environmental institutes as staring points; here the network was too small to render). To these were added 'Environment all academic and public 1' (including as starting points in the Issuecrawler harvester all the institutes surveyed so far that had been classified as either academic or public institutes); 'Climate Change 2 international networks' (starting points the link pages from three international Climate Change network websites); and 'Environment interdisciplinarity institute 1 (google 20)' which refers to a google search with the keywords 'environment', 'interdisciplinarity' and 'institute', of which I copied the first twenty links into the harvester. Lastly, two more crawls were run on 'Environment Resource Sites 1' and 'Environment all US 1'. The latter was to determine for the selection of the planned case study the relative importance of US interdisciplinary environmental research institutes.[1]

2.3 Analytical tensions, ethnographic solutions

The problem is, then, how to interpret the network maps produced by the Issuecrawler without falling back onto the simplistic notion that the web – and specifically linking activity on the web – reflects social life (Rogers 2004). For example, it could be proposed that the absence of any significant network in the science-art sector may reflect a certain refusal on the part of actors to 'link up' or, more daringly, that it reflects a specific conception that those who engage the web-activity (e.g., the artists) have of themselves. It could also be seen as corresponding to the absence of any major funding streams, or to the relative infancy of the field. While the Issuecrawler can produce interesting results regarding the distribution of institutions on the web, it can say little about the motivations and practices that underlie the interlinking of websites. Also, some of the crawls yielded no network at all, that is, the urls provided as starting points were insufficiently linked amongst each other. This kind of result can be surprising and frustrating where it seems obvious that institutions are 'linked' to each other in a conventional metaphorical sense, through a shared research approach, a common history, personnel, etc.

[1] In addition, one crawl was conducted on interdisciplinary neuro-sciences, and two crawls on Interdisciplinarity in general. The latter yielded a network consisting primarily of science funding bodies, including the various UK research councils, some US funding bodies, and so on.

In short, while the Internet constitutes a rich and continually growing resource, while it can be used to establish the distribution of interdisciplinary research areas, and while it offers significant amounts of freely available information, it needs to be used with caution. The worldwide web can hardly be considered a reflection of the social world. Rather it needs to be seen as a peculiar aspect of socio-technological world. Institutional websites are part of an institution – understood in this context as a nexus of people, practices, technologies and discourses. Internet research can be explorative, lead into unexpected directions, and open up new fields, but when deployed in this way it can also become potentially unmanageable and get 'out of control'. A clear definition of research questions and some pre-defined limits (in terms of time, numbers of websites covered, etc.) seems advisable.

3. Science-Art

3.1 Methodology

The starting point for the mapping of the Science-Art field was the Biotech Art Symposium, organised by Arts Catalyst, a London-based organisation which acts as a key distributor of funding and instigator of science-art projects in the UK. The event provided rich information about institutions, artists, and projects, which were followed up through Internet-based research. In addition, the research fellow interviewed a number of people related to this field either as practitioners or through arts administration, attended some relevant events and conferences in the UK (including the "Neuroaesthetics Conference" organised by Warren Neidich at Goldsmiths College; the "Rules of Engagement" Conference, Arts Council Yorkshire; as well as a Tissue Engineering Workshop which was part of the AV festival in Newcastle in March 2006), surveyed the literature, and followed the leads given by other researchers.[2] Interviews were conducted with several arts administrators and artists, including Nicola Triscott – Director of Arts Catalyst; Rosy Greenlees – Director of the London Centre for Arts and Cultural Enterprise (LCACE); Joan Shigekawa – Rockefeller Foundation; Verity Slater – Wellcome Trust; Ruth Maclennan – artist in residence at BIOS, LSE; Rachel

[2] Thanks, in particular, to Mathew Kabatoff.

Chapman – artist, Arts Council Yorkshire; Elizabeth McKinnon – Dept. of Heritage, Canada; Monika Fleischmann – MARS, Fraunhofer Institut, Germany. The reports by Michael Century (1999), Pamela Jennings (2000), and Michael Naimark (2003, rev. 2004) supported by the Rockefeller Foundation were a rich source of institutions, including brief descriptions of their work. Other valuable publications included the study by the Computer Science and Telecommunications Board (CSTB) of the US National Academies, entitled *Beyond Productivity* (2003); the Calouste Gulbenkian Foundation publication *Strange and Charmed: Science and the Contemporary Visual Arts* (Ede 2000a); and Stephen Wilson's encyclopaedic account *Information Arts* (2002).

3.2 Genealogies of Science-Art and New Media Art

Leonardo da Vinci is the perhaps most frequently cited 'precedent' for of art-science-technology engagements, and his work is now invoked as a prototype of practice that vanished with the Renaissance. *Leonardo* is also the title of a key journal in the field (MIT Press). Nowotny et al. speak of Leonardo da Vinci as exemplary of the kind of Mode 2 transdisciplinary endeavour. However, other commentators identify more recent precedents for science-art engagements. Science art involvements may be traced to the Bauhaus in Weimar, Germany; or to the 1940s and 50s, when MIT hired its first artist Gyorgy Kepes, and when cybernetic theories were taken up in social theory and thought. Another important experiment is E.A.T (Experiments in Art and Technology) founded by Robert Rauschenberg and Bell Labs physicist Billy Klüver in 1960s New York. E.A.T.'s objective was to instigate 'an international network of experimental services and activities designed to catalyze the physical, economic and social conditions necessary for cooperation between artists, engineers and scientists' (in Century 1999). In parallel, Bell Labs pursued research into computing, graphics, music and acoustics. The emergence of new media art is often traced to the 1980s (although, of course, photography, film, video could also be considered new media). Computers had been used earlier in music, and in experimental art. The increasing affordability of computers since the 1990s paved the way for a wave of various forms of computer and, later, web-based art. Another key moment, cited by Anne Barlow, was the exhibition "Growth and Form" curated by Richard Hamilton at the ICA in 1951 and the later exhibition "This Is Tomorrow" by the Independent group, which included Richard Hamilton, at Whitechapel Art Gallery in London in 1956 (Moffat 2005). Century (1999) suggests that the development of interdisciplinary studio laboratories in the 20th century corresponds to important shifts in techno-scientific-economic paradigms. In the early 1990s in the UK, Science Art was still a relatively marginal and emerging field. This changed with the launch of the Wellcome Trust's SciArt programme, and the subsequently formed SciArt consortium consisting of several organisations, including Arts Council England, Wellcome Trust, British Council, Gulbenkian Foundation and NESTA. Despite – or because of – its increasing popularity, science-art engagements have remained controversial:

> "Seen by some as mere window dressing for an otherwise haughty and inscrutable scientific established, by others as a grant-grabbing exercise for artists of no distinction, the genre's most outspoken critic is Lewis Wolpert, Professor of Biology as Applied to Medicine at University College London, who insists that it is wrong-headed in principle to suggest any possible common purpose between professional artists and scientists, and certainly folly to fund it" (Crichton Miller n.d.).[3]

3.3 'Genres'

Wilson's (2002) encyclopaedic overview – are art projects that draw on biology, physical sciences, mathematics and algorithms, kinetics, telecommunications, and digital systems. The new forms of art that emerge are given a variety of names, including SciArt, Bioart, Wet Art, Biotech Art, Media Art, Web Art, New Art, Space Art, Computer Music, Electronic Music, New Music. Michael Naimark uses the broad term

[3] Wolpert is a Fellow of the Royal Society and the former chairman of COPUS (Committee for the Public Understanding of Science).

New Art, in the sense of ‘art that no one has ever made (or seen) before’ (2003: 7), much of which today is technology-based. This New Art has been given various names:

> Computer Art or Digital Art stresses the use of processing in the work. Media Art and New Media Art ranges from a McLuhan-esque view that the medium affects the message, to an explicit interest in new media technologies. Art and Technology, Tech Art, or Techno-Art, is about the potential symbiosis between these two fields. Electronic Art may sound more general, but is most associated with Ars Electronica in Linz, Austria, the largest competition and festival of its kind. Cyber-Art became a fashionable terms as cyber-anything became fashionable […]. Art and Science, or Science Art is the oldest and least timely of these terms, harkening back to the world before the Industrial Revolution, when they were perceived inseparable. (2003: 7)

In *Beyond Productivity: Information Technology, Innovation, and Creativity* (2003), the authors simply use the catch all term information technology and creative practices (ITCP), which includes such diverse things as media art and computer games. However, this study would seem to both go beyond and be more limited than our concern with interdisciplinarity. Interestingly, Wilson’s categories mirror areas of scientific and technological enquiry (e.g. biology, ecological art, GPS, robotics, artificial life). He chooses this as one possible way of organising the overview, and despite the fact that “artists resist categorization” (2002: 8). It seems appropriate as his focus is on individual artists; or rather, as he tries to cover all areas of techno-scientific research that artists have begun use in their work. Many of the artistic projects are ad-hoc and individual (or collaborations between individuals) rather than institutionally based.

3.4 Motivations

Science art collaborations have been variably understood as being a way of fostering innovation, e.g. in new media R&D contexts, or as a different form of engaging with ‘the public’ and fostering greater public understand of science. While the incorporation of ethnographic knowledge into IT research may be seen as a way of connecting up with actual or potential, culturally ‘other’ users, artists are sometimes seen as future users, being considered in many ways ‘ahead’ of the societies in which they live. Wilson (2002: 8f.) distinguishes four approaches taken by artists towards techno-scientific research:

- Exploration of new possibilities (the work of the artist is an investigation/development of techno-scientific issues/research)
- Exploration of the cultural implications of a line of research (the artist’s work is a critical commentary on the cultural implications of a specific technology, scientific research etc.)
- Use of the new unique capabilities to explore themes not directly related to the research (the artist uses a particular technology but in a context/to explore a theme unrelated to techno-scientific research)
- Incidental use of the technology (the artist uses technologies/scientific findings etc. for aesthetic reasons, rather than because of an interest in the techno-science realm)

Michael Naimark proposes six reasons why artists’ inclusion in research labs may be valuable to science. Art projects may stimulate and provoke, and thus enrich scientific research; they may assemble an unconventional mix of disciplinary skills and talents; they can offer the content required for the testing of tools (and *vice versa*); they may allow scientists to observe human behaviour (the artist as user); they may trigger innovation and new paths for research; and, finally, the artistic exhibition or show of the outcomes of the research may be a test for their launch in the real world.

3.5 Typologies: Forms of Collaboration – Degrees of Institutionalisation

Most of the surveyed reports on Science-art propose typologies of one kind or another, due to their concern with funding and institutional structures. Century, for example, proposes a classification along the lines of organisational and funding structures (e.g., publicly funded, private-sector funding, affiliated to universities) and related forms of institutionalisation. He distinguishes between

- Institutions
- R&D laboratories in publicly financed cultural organisations (e.g. IRCAM, ZKM)
- Art-labs in private sector firms (e.g. Xerox PARC, NTT ICC, Interval Research Corporation)
- University/Public Sector Studio-Laboratories (e.g. GMD, Centre for Advanced Visual Studies at MIT)
- Networks
- Research networks
- Civil Society Focus
- Art Production Focus
- Projects and targeted funding schemes
- Art-Science award schemes (e.g. Wellcome Sci-Art)
- Hybrid Work Space – the temporary Media Lab Model

Similarly, Naimark notes that ‘tech-based art is largely supported by two different kinds of institutions: art centers with an interest in the new technology and research labs with an interest in art’ (2003: 12). These may be university based, corporate based, government funded, or completely independent of any institutional environment. He distinguishes, among others,

- Research labs with an art presence (MIT Media Lab, Media Lab Europe and Media Lab Asia)
- Corporate research labs with art presence (Xerox PARC, Interval Research Corporation, ATR Art and Technology project/Japan, Intel Corporation)
- University-based labs with corporate support (Interval now supporting NYU’s Interactive Telecommunications Program, Royal College of Art’s Computer-Related Design Department)

- (European) government-funded organisations with strong 'social' interest but also some marketing of results (Interactive Studios Sweden, Ars Electronica FutureLab Austria)
- Dedicated colleges (School of the Visual Arts New York, Arts technology Center at University of Mexico, iEAR Studios at Rensselaer polytechnic Institute, Cal[IT]2 New Media Arts research Layer of UC Irvine and UC San Diego, NYU's Interactive Telecommunications Program; Japan: Keio University SFC, Tama Art University, Tokyo University, IAMAS, Inter Medium Institute, Center for Arts and Media; Italy: Interaction Design Institute Ivrea; UK: Computer-Related Design Department at Royal College of Arts; CaiiA Star)
- Academic non-departments (SmartLab at Central St Martins, NYU's Center for Advanced Technology)
- Centres within public institutes (MARS Lab in Fraunhofer Research institute, Banff New Media Institute in Banff Centre for the Arts)
- Large publicly and privately funded institutions combining research with exhibition centers, publishing etc. (V2_ Institute for the unstable Media, C3 Center for Culture and Communication Budapest/Soros foundation; ZKM; Ars Electronica)
- Combinations of exhibit, business and critical stance on culture (de Waag Society Netherlands, ToroLab Tijuana Mexico, Trinity Session Johannesburg)
- And, especially in the US where public funding is rare, exhibition spaces relying on patrons, donors, sponsors (The Whitney Museum of American Art, The Kitchen New York)

In her presentation at the Biotech Art Symposium in April 2005, Nicola Triscott, director of the Arts Catalyst, distinguished the following forms that collaborations between artists and scientists may take:

- the classic model of teaming up, the artist/scientist pair
- residencies, placements, or internships of artists in science labs
- the paid model of specifically commissioned work (example: Eduardo Kac)

- the multi-disciplinary research group – a model that is just beginning to emerge
- the independent multi-disciplinary laboratory (added in interview May 2005)

An example of the latter would be the Makrolab organised by Arts Catalyst. Similar propositions for temporary labs have also been made by media and cultural theorist Geert Lovink, and implemented, for example, at Documenta. The 'lab' or 'studio-lab' is regarded as a very successful and sustainable form of art science production, suggested by both Century and Naimark in their reports for the Rockefeller Foundation. Naimark speaks of the 'Arts Lab' – a unique hybrid art centre and research lab in which tech-based art is both researched and produce, consisting of one artist and several staff (estimated cost $4 million per year). It is conceived as a not-for-profit organisation that relies on grants, but also offers services, and generates some commercial work, as well as patented IP and sell originals and editions.

3.6 Interdisciplinarity

Collaborations are not unusual in the arts world and some people see collaboration with scientists merely as a developed form of collaborating, for example, with somebody from a different arts discipline. However, for others there is something decidedly new about science art collaborations. Influenced partly by Gibbons et al. (1994), Century claims 'that in the margining digitally networked society, the creative arts and cultural institutions in general are mutating by forming a constellation of productive relationships with the science and technology research system, industry, humanistic and social science scholarship, and with the emerging new structures of civil society' (1999, no paging). A distinction may be made between the artist being the locus of interdisciplinarity, combining in him or herself artistic sensibilities and creativity with technology mastery or scientific knowledge; and the process of the production of art as an interdisciplinary endeavour, defined here as a collaboration between people from various disciplines (with all the gradations between the two).

For example, Nigten (2002) distinguishes between ‘multidisciplinary’ and ‘interdisciplinary’ approaches. Based on her observations at V2_, she notes that there has been a move towards what she considers truly interdisciplinary projects. Whereas previously, the artist was dependent on technicians and programmers, more recently, artists have attempted to acquire technical/programming skills. This allows the artist not just to work in a team but to participate in a collective process: the artist directs the project but can now also participate ‘hands-on’, and misunderstandings can be avoided. The collaborative team in which roles are completely merged is thus seen as an obstacle in the creative process; ideally, the artist is expected to possess all the relevant skills and knowledge that allow an independent production of the artwork. This notion would seem to tie in with the conception of the artist as a creative individual – sometimes a romanticised, lonely figure, which today is frequently considered to be outdated. Rather, in recent years it had become more fashionable for artists to work in collaborative teams and to acknowledge the work of others that had gone into the production of a particular piece.

3.7 ‘Society’

Society, the public, or people appear most frequently as passive (or ‘interactive’) recipients or users. There are four distinct ways in which they appear in Science art collaborations:

- the public showing of art work (another, perhaps more accessible, way of transmitting knowledge about science)
- explicitly educational projects (including museums, workshops in schools)
- the involvement of users in applied/commercial interdisciplinary projects
- the artist as user-to-come

The latter is often coupled with the notion that such projects contribute to or anticipate a future society; this is the case especially in the field of new media. As Century argues ‘seeing the artist as a cognitive pioneer only […] weighs to heavily on the side of theory; learning through using is how artists have always fashioned their poised balance between form and content, technique and idea' (1999, no paging). In a similar vein, the Interactive Institute in Sweden is founded on the assumption that the role of art is in 'prototyping' and in 'catching the long-term perspective' as regards technology and social development (see Naimark 2003: 15). Another way in which 'the public' or 'society' is attended to is in discussions of the questionable elitism of art and music, and how they could be made accessible to a wider public and indeed a blurring of the boundaries, e.g., between elite and popular music traditions (Chadabe 2000). Technology, Chadabe suggests, will have major democratising effect on computer music, to the extent that it will allow a wider public to participate in it through interactive devices.

In accounts of interdisciplinarity, more generally, there is a pronounced concern with the researcher's persona, including his or her specific 'qualities', 'characteristics' or 'dispositions' – such as curiosity, flexibility, adaptability, an open mind, creativity, good communication and listening skills, an ability to absorb information rapidly, and being a good team worker as ideal requirements (Bruce et al. 2004: 464). The ethos of the researcher thus includes the ethics of research – well-established field in clinical practice – but also the role and conduct of the scientist (and the artist). In the field of Science art, the new figure invoked is the artist-cum-researcher, the modern-day Leonardo, transcending the perceived deep divide between technoscience, on the one hand, and art, on the other. For the purpose of this study, the focus was on projects that seek either to explore techno-scientific possibilities (Science/Art A) or to comment – sometimes critically – on the cultural implications of science and technology (Science/Art B). This excludes those artistic projects that, deliberately or accidentally, make use of new technologies but explore themes unrelated to science or technology. The boundaries between Science/Art A and B are, of course, fuzzy. Artists may be conceived of as 'future users', always at the forefront of cultural developments in their respective society, as exemplified by experiments with involving artists in IT research. The involvement of artists in IT research may be usefully contrasted with the involvement of anthropologists and other social scientists who do not stand in as future users but rather are assumed give an insight into the life of 'really existing' or 'culturally other' users. Within Science/Art B are included public understanding of science (PUS) projects, such as an exhibition on new genetics technologies sponsored by the Wellcome Trust – as well as a project by artists working at the Australian Science/Art outfit SymbioticA who tried to be included in the same exhibition but were turned down. Their artwork – pig's wings created from tissue cultures – was intended as a critical commentary on the hype surrounding contemporary genetics research. PUS-type Science/Art is sometimes accused of merely and uncritically serving science and to remain wedded to a modernist conception of scientific research as progressive and intrinsically positive. Intriguingly, art seems to be considered an easy-access vehicle for translating and delivering information about scientific research to the public.

3.8 Outputs and products

Wilson notes that '[f]or many years the mainstream art world of museums and galleries ignored techno-scientific-inspired art. […] As a result, pioneering artists found alternative exhibition venues, […]. We are now at a transition point. There are signs that museums and galleries will begin to show more interest in science and technological topics, and established artists are beginning to explore technical tools and contexts' (2002: 883). Science-Art collaborations can yield products that are not purely 'artistic' but have a direct application. Software is perhaps by now quite a common product, but there are also more unusual ones. For example, Elizabeth Goldring collaborated with scientists at MIT producing a Visual Language for the Blind – a visual language projected directly onto the retina through a scanning laser ophthalmoscope (Wilson 2002:169). This raises questions of authorship and of intellectual property rights. The patenting and licensing of software and products has become quite common and an important financial source; MIT Media Lab offers its IP to corporate sponsors as paid-for, exclusive information. Simultaneously, however, there is also the emergence of what is called 'creative commons', of open source and access software, and the like (see also Naimark 2003). In interview, an arts administrator noted that some artists' lack of concern with IP rights would appear to contradict commercial interests; however, she suggested the (initial) unrestricted publication of artistic work might eventually enhance its marketability. More generally, however, there is a sense that as collaboration is becoming more common, the input of several people into the work can be more readily acknowledged.

3.9 Funding

Following Naimark (2003), the following forms and sources of funding may be distinguished:

- Research labs with an art presence (MIT Media Lab, Media Lab Europe and Media Lab Asia)
- Corporate research labs with art presence (Xerox PARC, Interval Research Corporation, ATR Art and Technology project/Japan, Intel Corporation)
- University-based labs with corporate support (Interval now supporting NYU's Interactive Telecommunications Program, Royal College of Art's Computer-Related Design Department)
- European government-funded organisations with strong 'social' interest but also some marketing of results (Interactive Studios Sweden, Ars Electronica FutureLab Austria)
- Colleges (School of the Visual Arts New York, Arts technology Center at University of Mexico, iEAR Studios at Rensselaer polytechnic Institute, Cal [IT]2 New Media Arts research Layer of UC Irvine and UC San Diego, NYU's Interactive Telecommunications Program; Japan: Keio University SFC, Tama Art University, Tokyo University, IAMAS, Inter Medium Institute, Center for Arts and Media; Italy: Interaction Design Institute Ivrea; UK: Computer-Related Design Department at Royal College of Arts; CaiiA Star)
- Academic non-departments (SmartLab at Central St Martins, NYU's Center for Advanced Technology)
- Centres within public institutes (MARS Lab in Fraunhofer Research institute, Banff New Media Institute in Banff Centre for the Arts)
- Large publicly and privately funded institutions combining research with exhibition centers, publishing etc. (V2_ Institute for the unstable Media, C3 Center for Culture and Communication Budapest/Soros foundation; ZKM; Ars Electronica)

- Combinations of exhibit, business and critical stance on culture (de Waag Society Netherlands, ToroLab Tijuana Mexico, Trinity Session Johannesburg)
- US exhibition spaces relying on patrons, donors, sponsors (The Whitney Museum of American Art, The Kitchen New York)
- US art galleries that represent, sell and make/reproduce tech-based art (Carl Solway Gallery Cincinnati, Postmasters Gallery New York, Barbara Gladstone Gallery New York) (but galleries are often subsidised by sponsors or wealthy families)
- Artists selling their art in novel ways (e.g. software) generating their own economies
- Large scale programmes intended to fuel innovation combining Social Return on Investment with Financial Return on Investment (Program Venture Experience by Rockefeller Foundation, NESTA)
- Publishing houses, companies, etc. with Innovative marketing strategies (The New Press, 3-Legged Dog theatre company with spin-off Shape of time)
- Organisations with guided corporate support (Viewpoints Research Institute, Computer Clubhouse)
- Non-profit groups with variable, innovative funding ideas (RTMark anonymous artists system, Black Rock event and Foundation)
- Foundations (US National Endowment for the Arts only supports individual artists in fields of literature, jazz and heritage; Rockefeller Foundation has media arts fellowship program since 1988, Creative Capital Foundation founded in 1999, Canadian Daniel Langlois Foundation since 1997 is one of the largest tech-based artist funder in the world)
- Not-for-profit tech-based art organizations with support from high tech corporations and new entrepreneurs in 1990s (Eyebeam New York, ZeroOne Silicon Valley)
- Patenting and selling of IP
- Selling of originals and editions
- Commercial PR sponsorship

- Selling of commercial external services (e.g. consulting, commissions) (Benetton-funded Fabrica Center Venice)
- Grants and donations

The mapping survey showed that the field of science-art is still emergent with few institutions focused on this kind of interdisciplinary practice. The selected case studies included both university based centres (ACE, UC Irvine) and, for the UK, funding programmes (AHRC and Arts Council Research Fellowships; Wellcome Trust Sciart programme). A further short case study was conducted at SymbioticA, a science-art lab at the University of Western Australia.

4. Environmental Research

Two factors have contributed to the prominence of interdisciplinarity in environmental research. First, in the last three decades there has been a significant re-thinking regarding the nature of the relationship between the environment and human beings or nature-society relations (Becker & Jahn 2005), which became politically significant from the 1980s onwards. Secondly, there is now growing emphasis on so-called evidence-based policy and the participation of stakeholders and user groups in research which itself has become increasingly policy-directed (Petts et al. 2004: 1). In this context, he social sciences are considered particularly useful in building bridges between policy, science, and society. The study of the environment has long been conceived of as inherently multi- or interdisciplinary, drawing on a wide range of natural and physical sciences. However, the inclusion of social scientific expertise may be considered a more recent phenomenon. Increasing attempts are made to refine integrated analyses of environmental problems, which would allow a simultaneous assessment of natural, social and structural aspects; and scenario tools and stakeholder workshops are used to develop solutions, rather than providing truths.

4.1 Methodology

In contrast to science-art, the mapping of the field of environmental research was primarily internet-based. Initial leads were provided by a select group of existing contacts in this field, including, Kristin Asdal (Centre for Technology, Innovation & Culture, University of Oslo) and Gail Davies (Dept. of Geography, UCL). Following a systematic 'google' search using certain key words ('environment – interdisciplinarity'; 'environmental research institutions'; etc.) links were followed up, of both institutional websites and, for example, the institutional affiliations of speakers given on relevant conference websites. This was complemented by a literature research, focusing primarily on texts discussing recent efforts to rethink the theory and practice of research on the environment (see below). Considering these was vital to understand the important differences between established forms and notions of interdisciplinarity within this field and more recent self-consciously inter-, cross-, or transdisciplinary efforts as well as attempts to involve 'society' in research on the environment.[4]

4.2 Shifting Ontologies

Arguably, interdisciplinarity has a long-standing history in the field of research concerned with the environment. Many of the contemporary interdisciplinary research institutions identified have emerged out of previous efforts at bringing together researchers from disciplines, such as, the earth sciences, environmental sciences, development studies, and (environmental) economics, ecology, or geography. Geography, as a discipline, is characterised by its "contested and pluralist tradition" (Livingstone 1992: 347), and its familiar internal differentiation between physical and human geography. Indeed, it is this tension that has given geography its reputation as "the integrating discipline par excellence that kept the study of nature and culture under one disciplinary umbrella" (ibid.: 354).

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[4] The survey did not include artist in residence programmes in environmental research institutions or the large number of artists working on themes to do with nature or the environment.

The perceived need for interdisciplinarity has been partly related to shifting conceptions of the disciplinary research objects. Since the 1970s, a perception of our planet as consisting of various highly inter-related components has emerged reflected, most prominently perhaps, in the sustainability discourse. Similarly, in climate change research since the early 1980s, the impact of so-called anthropogenic factors has been increasingly recognised. Climate and earth scientists began to look towards geography, economics, the political and social sciences for approaches that would allow an integration of social or human aspects into their models (see Liverman 1999). Interdisciplinarity, here, seems driven by a re-thinking of the central problematic of research, namely, what makes the environment or earth system? This produces a search for a certain kind of holism – albeit different from that pursued in anthropology – to be achieved through interdisciplinarity.

Concepts that have typically organised natural scientific environmental research have been air, land, plants, water (or oceans), i.e., the various aspects or media of the environment (Jahn 2003). Alternatively, research has focused on what are understood as the distinct spheres of the environment system, such as atmosphere, biosphere, lithosphere and hydrosphere. While these concepts are still in use, others have gained prominence, reflecting an increasing problem orientation, including 'pollution' or 'climate change', as well as 'sustainability'. Referring specifically to the German context, Thomas Jahn (2003) notes that environmental research reached an impasse in the late 1980s and early 1990s. First, there was a noticeable discrepancy between the investment in this research and the achieved results and insights. Secondly, rather than searching for technologies that might mitigate the impact, there was now a demand for more preventative solutions to environmental problems. In addition, the emergent sustainability discourse provoked a search for new methodologies that would combine domains which, prior to the invention of 'sustainability', had been considered separately (such as ecology, economy, the political and the social). In the natural scientific environmental research, greater emphasis was placed on systems science approaches. In the social scientific environmental research, a series of new sub-disciplines has begun to form, including environmental law, environmental economics, environmental psychology, and so on. Further new 'hybrid' research fields or fledgling disciplines have been human or cultural ecology, ecological humanities, sustainability science (U.S.), earth systems science, and two distinct variants of social ecology – one in the US and another in Germany. The institutions covered by the online research usually emphasise one of these 'hybrid' approaches and disciplinary forms.

4.3 Institutional and Non-Institutionalised Forms

The survey shows that institutes devoted to environmental research first emerged in the late 1960s and early 1970s – when the environment gained its place on the political agenda (Carter 2001: 1). Founded in 1967, the School of Environmental Sciences (ENV) at the University of East Anglia was one of the first to bring together scholars from a variety of disciplines. Other early institutions included the International Institute for Environment and Development (IIED) founded in 1971, and IIASA founded in 1972. The Club of Rome published Limits to Growth in 1972. The subsequent establishment of environmental institutions appears to have happened in 'waves', in relation to global policy developments as well as the perceived amplification of environmental crises. A second set of institutions were established in the late 1980s and early 90s, many of them in explicit response to the 1987 Brundtland report and the Earth Summit in Rio de Janeiro in 1992 (e.g., The Beijer Institute, Sweden 1977/1991; NINA 1988; Stockholm Environment Institute (SEI) 1989; ISOE 1989; Regional Environmental Centre for Central and Eastern Europe 1990). More recently, with the Kyoto Protocol in 1997 and the World Summit on Sustainable Development in Johannesburg in 2002, further institutions have been founded (e.g., The Tyndall Centre 2000).

- For an initial typology, these institutions may be distinguished in terms of their funding base and governance arrangements, i.e., their institutional affiliation and the like:
- university departments (e.g., ENV; ECI, Oxford; IFF, Austria; IVM; SUM; IRES)

- university research networks/centres (e.g. ICTA, Barcelona; HUCE, Harvard; SENSE, Netherlands; CIESIN, Columbia University;)
- university-affiliated research institutions (e.g., Tyndall Centre, Norwich; IRES, Newcastle;)
- national publicly (government) funded independent research institutions (e.g., ISOE; PIK, UFZ; DIFU; Wuppertal Institute; KINT, Belgium; UKERC; CIRAP; NINA, Norway; IGES, Japan)
- international government funded research institutions (e.g., IIASA)
- mixed-funding research institutions, including think tanks, NGO-type organisations, and consultancies (e.g., Ecologic, Germany; SERI, Austria; TERI, India, CSE, India)
- networks
- issue-specific committees/panels/commissions/'task forces'

Committees or commissions set up for the purpose of managing public consultations are here considered as non-institutionalised forms of interdisciplinarity. Rather, they are issue-specific and usually temporary. Examples include:

- CoRWM (Committee on Radioactive Waste Management), an independent body appointed by Government Ministers in England, Scotland, Northern Ireland and Wales. Its task is to review the options for managing the UK's radioactive waste and recommend those options that can provide a long-term solution which protects people and the environment.
- Intergovernmental Panel on Climate Change (IPCC) (see above). The IPCC is identified by Clark et al. (2004) as a "genuine post-Copernican creation" operating in the interdisciplinary spirit of the recent Earth system science.

Clark et al. suggest some guidelines for the "the kinds of institutional reforms and innovations that are needed to harness science and technology better to the tasks of enabling and guiding a transition toward sustainability" (2004: 21). These include the gearing of the R&D agenda also to the priorities of local decision-makers; a focus on the production of solutions rather than identification of problems; responsiveness to political issues and S&T simultaneously. Interestingly, the institutional form that Clark et al. suggest will best accommodate future research demands is that of the ad hoc task force (panel, commission etc.) – which, for reasons of stability and learning, could be coupled with a small professional secretariat. An example would be the Interacademy Panel on International Issues. But future investments, they argue, have to support simultaneously individuals, organisations, and networks.

This is only a rough chronology and typology. Jahn (2003: 5) observes that while research in Germany was long comprised of two 'sectors' – the classic university research and government funded, extra-university research – a third sector began to take shape in the 1980s, that of small, non-profit ecological research centres. Initially, these were engaged in 'advocacy' research – often in close collaboration with citizen initiatives, social movements and individual protest groups. Today, they may work even with industrial partners and have developed into more specialised and quasi-academic research institutions. It is here, Jahn suggests, that a new mode of knowledge production was first conceived – a mode which was transdisciplinary, both problem- and actor/society-oriented, and also open to economic and political issues and requirements.

4.4 Multidisciplinarity – Interdisciplinarity – Transdisciplinarity

Interdisciplinarity in environmental research has been taken to refer to various types of collaborations among natural or earth scientists. However, there are many institutions with staff from a variety of disciplines, including both natural and social sciences. Judging from the Internet-based survey of websites, it is sometimes unclear to what extent interdisciplinarity is a feature common to all research in a particular institution or whether only some individual research projects are interdisciplinary in the sense defined in our project proposal. Generally speaking, interdisciplinarity is particularly prevalent in research on 'sustainability' or where stakeholder participation is an aim. However, it can be observed that interdisciplinarity has become increasingly salient as a term of self-description, a mode of research, and an issue to reflect upon. Efforts are made to define and refine new kinds of research. In some cases there was explicit reference to the terms of analysis provided by Gibbons et al. (1994) or Nowotny et al. (2001) (e.g., Becker 2003; Clark et al. 2004; Jahn 2003). Thus one can find typologies such as the following, suggested by the participants to the ESRC Transdisciplinary seminar-series “Knowledge and Power: Exploring the Science/Society Interface in the Urban Environment Context” (Petts et al. 2004: 5-6, drawing on Bruce et al. 2004):

- multi-disciplinarity “involves a number of different disciplines coming together, but each disciplinary grouping working primarily with their own framings and methods”
- inter-disciplinarity “involves ‘occupying the spaces between disciplines’ to build new knowledge [and] applications of different sets of skills to physically self-evident problems”
- trans-disciplinarity is “a practice that transcends, challenges or renegotiates traditional disciplinary boundaries and in some cases reconstructs them in new positions”

Similarly, Becker (2003) and Jahn (2003) suggest that the new field of ‘social-ecological research’, developed by ISOE and taken up in public funding programmes, belongs to a new type of research as outlined by Gibbons et al. (1994). This is the ‘transdisciplinary’ type which is oriented at societal problems and sits at the interface of science (*Wissenschaft*), politics, the market (*Wirtschaft*), and the public. However, they also emphasise that applied and problem-oriented research needs to be accompanied by a search for new methods and theoretical models.

4.5 Society

As noted above, it was partly the re-conceptualisation of the object of study that prompted interdisciplinary study in the environmental field. Moreover, it is now widely accepted that, as Clark et al. write, “the ultimate need is for a problem-driven, theoretically grounded, integrated approach for characterizing and measuring what we most value in coupled nature-society systems we inhabit" (2004: 20). It has been suggested that future research institutions need to be driven by actual, local and global, concerns, and have as a core purpose the facilitation of dialogue between experts and decision-makers and the production of "useful knowledge by scientists and problem-solvers" (ibid.: 21). Clark et al. of a new 'social contract' between society and S&T – replacing an older, successful one at work in the industrial(ising) world where society's strong investment in science was presumed to result in economic growth and national security.

Attention to 'society' as an integral part of research has had many different motivations. The inclusion of 'people' in research – and especially in the implementation of solutions to environmental or development problems – partly derives from more long-standing criticisms of technocratic planning. Such criticisms emerged from the late 1960s and especially the 1970s onwards and were sought to be remedied through greater direct participation. In development studies, this was accompanied by a rethinking of the universality of science and rational thought and the recognition of 'other', 'indigenous' modes of thinking.

In this context, interdisciplinarity, i.e., the involvement of social scientists, is understood as an important way of bringing 'society' into the research. The social scientist are thought to enable a better understanding of people's 'own' views and to facilitate communication to prevent the failure of previous policy, development, and planning (e.g., CSERGE; Öko-Institut, Tyndall Centre). While some refer simply to 'society' as an entity, for others it is 'the public' (or specific publics), social groups, actors, stakeholders or citizens that need be addressed.

But interdisciplinarity can also mean a more abstract involvement of 'society'. For example, in Earth System theory, society is brought into the equation through the use of specific modelling techniques – often borrowed from mathematics or economics (energy flows etc.). In this case, it is the techniques that are adapted – as they are to take into account the object of research of a previously distinct discipline.

Conversely, (natural scientific) techniques are brought in to see and research society in a different way. This is a fourth mode of interdisciplinarity, in addition to those proposed at the outset of the research project.

On the basis of this survey, the following institutions were selected as cases studies: Tyndall Centre (UK), Wuppertal Institut (Germany) and Öko-Institut (Germany), Earth Institute at Columbia University (U.S.).

5. **IT & Ethnography**

This field of interdisciplinary research has its roots in the late 1950s, early 1960s and the increasing concern with the ways in which human beings could and did use computer technologies. Initially, the field was dominated by psychology and ergonomics, and addressed questions of usability and what came to be called 'human factors'. The Work Practices and Technologies group set up by Lucy Suchman at Xerox PARC 1970s may be seen as both an extension and a significant break with the previous research. Suchman was interested in what she termed 'situated actions' and how people actually used and 'interacted' with the technologies, and introduced a decidedly qualitative approach to research these aspects. In other words, while the computer had initial been considered as an 'extension of the mind', we might say that it gradually became understood that one was dealing with embodied minds – the body of the user began to play a role in the development of ICTs.[5]

In the 1980s, the notion of 'user-centred design' was developed. The aim was to work out what the needs of the intended users are by looking at real people – rather than the researchers viewing themselves as prototype users. In short, while the involvement of artists in IT is often understood in terms of 'future users', ahead of

[5] Another area in which anthropology has applied itself in relation to ICTs is marketing (as opposed to technology development). However, there it is primarily quantitative data that is used to identify and target markets for already existing products, and to define new users.

their time, the involvement of anthropologists seems spurred by an interest in the life if 'real' or culturally 'other' users. There was an acknowledgement that people with varying social, cultural, educational backgrounds have different requirements which may not always be obvious to researchers. Crucial in the development of this field were IDEO, Royal College of Arts and the Interval research centre. By the mid 1990s, a new design discipline called 'Interaction Design' had gradually taken shape. It came out of interface design – which was considered different from other forms of product or technology design as the computer interface was regarded as a new, as yet undefined space that needed to be designed. Moreover, the idea of ubiquitous computing made designers more interested in thinking about people who are *moving* with technologies, or in and out of ICT spaces.

There is a set of core research centres that have been influential in the development of this field over the last four decades or so. Partly, these centres are linked through people and ideas moving from one to another, being taken up and further developed elsewhere. These centres include the Stanford Research Institute, Xerox PARC, Atari, MIT Medialab, IDEO, Interval Research Centre, Intel, Microsoft and others. However, the boundaries between these various forms of design taking 'human factors' into consideration and actual interdisciplinary groups are fuzzy. Judging from the websites, today, research by or with anthropologists and other social scientists is particularly prominent at Microsoft, Xerox, and Intel research. But other companies such as Philips and BT also conduct – both 'in house' and external – research of this kind.

6. <u>Discussion</u>

Given these problems and the diversity of interdisciplinary histories, what sort of analytic object is 'interdisciplinarity'? How can it be grasped and studied? Drawing on a variety of methods, the mapping survey aimed to establish what forms interdisciplinary collaborations take, and – in conjunction with the case studies – to show the new forms of accountability and the different ways in which 'society' or 'public interests' are modelled entailed in interdisciplinary collaborations. The process of mapping the field of interdisciplinarity was simultaneously a process of delineating the object of study and of creating its context. Establishing a context of a variety of institutions (small and large, public, university based, and commercial ones, etc.) helped determine which institutions are exemplary embodiments of interdisciplinarity. The aim was not to find some 'average' institution, however, but research outfits that appeared to exhibit the various specific facets of contemporary interdisciplinarity. This was only possible because the web-based survey – despite its shortcomings – provided what may be seen as a broad 'context'. "Context […] involves making connections and, by implication, disconnections" (Dilley 1999: 2). What sort of relationship do we assume to exist between the institutions that are our case studies and the web-based research, interviews, literature review, and document analysis we conducted? Given the diversity of fields and modes of research, it would be impossible to map all contemporary forms of interdisciplinarity. Indeed, some forms of interdisciplinarity may not be visible as interdisciplinarity due to dominant definitions applied by research councils and other research bodies.

Websites, policy documents, research programmes, scholarly publications, conferences, and exhibitions may be considered contextual components determinant of the meaning of interdisciplinary institutions. For example, to comprehend the interdisciplinarity of an institution, it is possible to point to a number of events, debates, and conjunctures, which have provoked or justified the need for it. We take the existence of institutions often as self-evident; but in an era of networking, collaboration, consultancy, and so on, what is the nature and what are the limits of an institution? The 'reality' of an institution is hard to determine from web-based research, alone. For example, centres may exist that have a name, address, logo, and a long list of members, but no physical place. In this context, it may not make sense to oppose an institutional with a network analysis: institutions can be distributed, nested, virtual, or networked. The difficulty is in thinking about institutions that are so dispersed and unstable that they can barely be understood as institutions (as seen in the case of Science-art). Moreover, the relation between an institution's self-representation on the web and what is happening in practice can remain opaque. There may be considerable discrepancies between an institution's representation of itself on the web and what is happening in practice. However, in interpreting these apparent discrepancies, it is crucial to consider how ‘success’ – and ‘failure’ for that matter – is locally perceived. Much contemporary interdisciplinarity seems to stem from an explicit concern with accountability. Interdisciplinarity, as Strathern (2004: 80) suggests, may even become an index of accountability – thereby pre-empting critical enquiries into disciplinary success. Conversely, we may also ask ourselves how, by studying their interdisciplinary success, we are participating in a project of holding institutions accountable. Therefore, rather than simply asserting that there is a mismatch between representation and reality, or ideology and practice, etc., web sites and other texts may be considered co-constituents of the interdisciplinarity of the institution in question. The institution, as its website, becomes part of an ‘assemblage’ of interdisciplinarity.

The mapping of the diversity of interdisciplinary fields, forms, and practices suggests a need for a more differentiated view. The following typology was suggested, centred on shared questions and problematics as defining element of interdisciplinarity:[6]

[6] This is a preliminary typology, which has been significantly refined by the project team based on the subsequent case studies.

Logic	Question/problematic	Exemplary cases	Aim
Progression of Knowledge	How can contemporary social 'complexity' be conveyed?		adequate modelling of contemporary society
Progression of Knowledge	What makes humans?	neuro- and cognitive sciences, anthropology	Convergence, integration
Progression of Knowledge	What makes the world system (the environment)?	Geography, climate change research, social ecology research	Convergence, integration
Progression of Art	How can innovation be achieved? (via art as research)	Science/Art	integration, experimentation, cultural production
Innovation	How can innovation be stimulated? (via folding in of 'the social'/'the user')	IT-anthropology Science/Art A	Convergence, "new" creativity, economic value
Accountability	Lack of accountability of techno-scientific research or How can the impact of techno-scientific research be managed?	ELSI in genetics or neurosciences	Anticipation/accountability, normativity/regulation
Accountability	Lack of understanding of /confidence in science in society	p.u.s. programmes (museums, schools etc., including some Science/Art B) nanotechnology, genetics	legitimacy, accountability
Accountability	How are science & technology socio-culturally constituted?	Science/Art B, STS, (some ELSI research)	critical commentary; to revise relationship between science and society

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