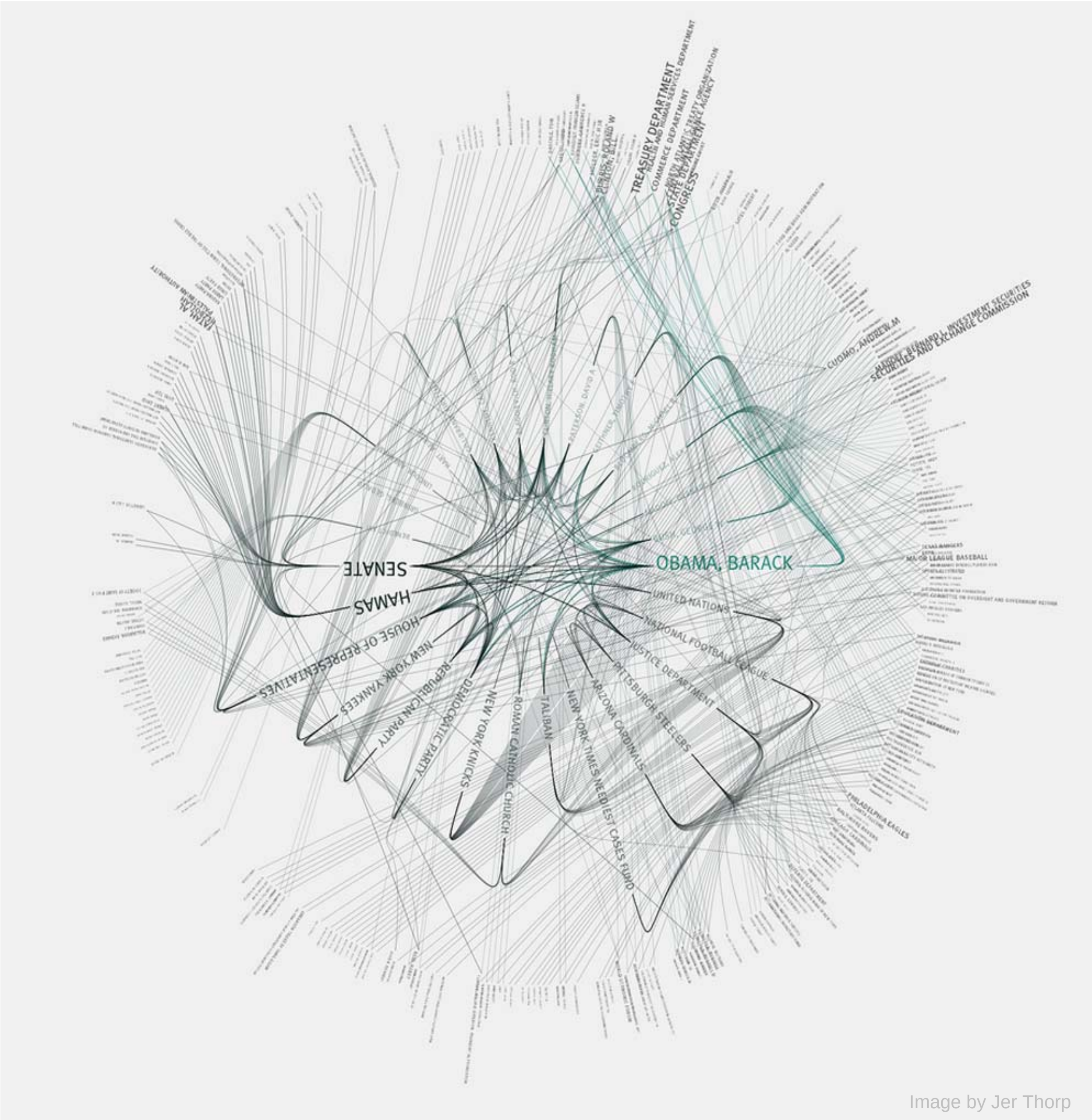
Visualisation in the Age of Computerisation

25-26 March 2011, University of Oxford



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University of Oxford

NTNU – Trondheim
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OeSS
The Oxford e-Social Science Project

C4D/
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Rooms:

LT4 = Lecture Theatre 4

SRA = Seminar Room A

ACSR = Andrew Cormack Seminar Room

LT5 = Lecture Theatre 5

Conference Programme

Friday, 25 March 2011		
9:00-09:30	Registration and coffee	Location: Entrance Hall, Saïd Business School, University of Oxford
9:30-10:00	**Welcome and opening remarks** LT4	Annamaria Carusi (University of Oxford), Aud Sissel Hoel (NTNU) and Timothy Webmoor (University of Oxford)
10:00-11:00	**Keynote 1** LT4	Steve Woolgar (University of Oxford): 'Visualisation in the age of computerisation'
11:00-11:30	Break and refreshments	Location: Entrance Hall
11:30-13:00	Paper session: **Visions of evidence** LT4	Catelijne Coopmans (National University of Singapore): 'Visual analytics: witnessing artful revelation in business intelligence' Emma Frow (University of Edinburgh): 'In images we trust? Setting guidelines for digital image processing in scientific journals' Erin Kruger (University of Western Sydney): 'Visualising uncertainty: law, DNA, and the quantification of "reasonable doubt"' Chair: Alex Soojung-Kim Pang (Microsoft Research Cambridge)
11:30-13:00	Paper session: **Philosophy of visualisation** SRA	Annamaria Carusi (University of Oxford) and Aud Sissel Hoel (NTNU): 'The measuring body: beyond quantitative/qualitative boundaries' Victoria Höög (Lund University): 'The epistemic perspective revisited: Quine's thesis of holism and underdetermination applied to visuality in the sciences' Nicola Mößner (RWTH Aachen University): 'Are visualisations a link to nature?' Chair: Willard McCarty (King's College London)

11:30-13:00	Paper session: **From vision to interpretation** ACSR	Richard Arias-Hernandez, Tera Marie Green and Brian Fisher (Simon Fraser University): 'From cognitive prostheses to cognitive amplifiers: understandings of the material basis of cognition in visual analytics' Min Chen (Swansea University) and Luciano Floridi (University of Oxford and University of Hertfordshire): 'An information map for visualisation' Ségolène M. Tarte (University of Oxford): 'The interplay of visual perception and cognition in digital papyrology: visualisation for interpretation, visualisation as interpretation' Chair: Michael Batty (University College London)
13:00-14:00	Lunch	Location: Entrance Hall
14:00-15:30	Paper session: **Visualising networks** LT4	Sarah de Rijcke and Anne Beaulieu (Virtual Knowledge Studio): 'Network realism: making knowledge from images in digital infrastructure' Anders Koed Madsen (Copenhagen Business School): 'Delineation devices at the root of social representation - a comparison of online entry-points for mapping the controversy about synthetic biology' Albena Yaneva (University of Manchester): 'Moving networks: architectural tools for tracing the social' Chair: Felix Reed-Tsochas (University of Oxford)
14:00-15:30	Paper session: **Filmic realities** SRA	Pål Aarsand (Uppsala University) and Anna Sparrman (Linköping University): 'Visual transcriptions as theory (and methodology)' Philip Brooker (University of Manchester): 'Videoing 'seeing' in the work of Astrophysics programming' Alma Steingart (MIT): 'Unspooling the topologist's videotape: from chicken-wires to film festivals' Chair: Javier Lezaun (University of Oxford)
15:30-16:00	Break and refreshments	Location: Entrance Hall
16:00-17:00	Paper session: **Data intensity and visual knowing** LT4	Andrew Hudson-Smith, Steven Gray, Oliver O'Brien, Richard Milton (University College London): 'Harvesting and visualising the crowd: Twitter space, bikes, surveys and data stores'

		Ruth McNally and Adrian McKenzie (Lancaster University): 'Latent semantic indexing of experiments as text: the making of a literary technology for the virtual witnessing of data production' Fabian Neuhaus (University College London) and Timothy Webmoor (University of Oxford): 'Massified research and visualisation. Network effects of data harvesting from Twitter, public API feeds and other social media' Chair: Ralph Schroeder (University of Oxford)
16:00-17:00	Paper session: **Identities of visualisation** ACSR	Robert Bhatt (University of Umea): 'Moving beyond beauty in medical imaging: an ethnographic study of the role of three-dimensional visualisations as boundary objects in medical science' Luis Felipe R. Murillo (UCLA): 'Partial perspectives in Astronomy: gender, ethnicity, nationality and meshworks in building digital images of the universe' Chair: Marina Jirotka (University of Oxford)
16:00-17:00	Installations and demo presentations: **Hands on visualising** SRA	Luke Church and Alan Blackwell (Crucible Network for Research in Interdisciplinary Design and University of Cambridge): 'Computation, visualisation and critical reflection' Gordana Novakovic and the Fugue team (University College London): 'Fugue' Alison Munro (Australian National University): ‘Thinking about science and drawing’ Chair: Federica Frabetti (Oxford Brookes University)
17:00-17:30	Break and refreshments	Location: Entrance Hall
17:30-18:30	**Keynote 2** LT4	Peter Galison (Harvard University): ‘Digital objectivity’
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Saturday, 26 March 2011

10:00-11:00	**Keynote 3** LT4	Michael Lynch (Cornell University): 'Image and imagination: an exploration of online nano-image galleries'
11:00-11:30	Break and refreshments	Location: Founders' Room
11:30-13:00	Paper session: **Envisioning biology** LT4	Johannes Bruder (University of Basel): 'Computing the brain. Images, models and visualisations in contemporary functional neuroimaging' Merete Lie (NTNU): 'Displaying human cells: scale and autonomisation' Janina Wellmann (Tel Aviv University): 'From 'seeing in-between' to the 'in toto' representation of the embryo. Representations of biological development ca. 1810 and ca. 2010' Chair: Tanja Schneider (University of Oxford)
11:30-13:00	Paper session: **Embodiment and visualisation** LT5	Matt Edgeworth (Durham University): 'Computer applications and their influence on perceptual encounters with material evidence during archeological excavation' Trine Haagensen (University of Oslo): 'Has the human left the building yet? Questioning the transcripted truths of prosthetic visualisation technology' Adam Rosenfeld (SUNY): 'From representation to performance: convergence of the dry-lab and wet-lab and manipulation of fictional models' Chair: Liv Hausken (University of Oslo)
11:30-13:00	**Poster session and demo** SRA	Amanda Windle (London College of Communication; University for the Creative Arts): 'Inscribing complexity: diagrammatic interventions' Dolores and David Steinman (University of Toronto): 'Biomedical simulations and their challenges to the medical visual culture' Jennifer Tomomitsu (Lancaster University): ''Seeing' as feeling: embodied material practices of 3D image reconstruction' Julie Palmer and Frances Griffiths (University of Warwick): 'Digital radiography in the post-photographic era'

		Luke Church and Alan Blackwell (Crucible Network for Research in Interdisciplinary Design and University of Cambridge): 'Computation, visualisation and critical reflection' (Demo)
13:00-14:00	Lunch	Location: Founders' Room
14:00-15:30	Paper session: **Professionalised vision** LT4	Phaedra Daipha (Rutgers University): 'Screenwork as the social organisation of expertise' Grace de la Flor, Marina Jirotka and Eric Meyer (University of Oxford): 'Accessing medieval music: from material codex to digital specimen' David Ribes (Georgetown University): 'Redistributing expert vision: crowdsourcing, agency and interface' Chair: Paul Jepson (University of Oxford)
14:00-15:30	Paper session: **Visual practices of objectivity** LT5	Chiara Ambrosio (University College London): 'Objectivity and representative practices across artistic and scientific visualisation' Bill Leeming (OCAD University): ''Computationally seeing' an epistemic space for genomic medicine' Matt Spencer (Goldsmiths): 'Image and imagination in computational modelling of fluid dynamics' Chair: Torben Elgaard Jensen (Technical University of Copenhagen)
14:00-15:30	Paper session: **Science and aesthetics** SRA	Roberta Buiani (University of Toronto): 'Of viruses, microscopes and computing: visualisation and the question of biopower' Sara Diamond (OCAD University): 'Aesthetic histories and material practices – the limits of visualisation and the limits of the real' Anja Johansen (NTNU): 'The sublime aesthetics of the cell' Chair: Martin Kemp (University of Oxford)
15:30-16:00	Break and refreshments	Location: Founders' Room
16:00-17:00	Paper session: **Ethnographies of the visual** LT4	Marko Monteiro (University of Campinas): 'Are scientific images good ethnographic sites? Interpreting remote sensing practices in Brazil' Daniel Neyland (Lancaster University): 'Notes from an ethnography of deleting' Chair: Udi Butler (University of Oxford)

16:00-17:00	Paper session: **Visualising controversies** LT5	Brigitte Nerlich and Kate Roach (University of Nottingham): 'Pictures, politics and persuasion – the case of Greenpeace's Sinar Mas campaign' Tom Schilling (MIT): 'Kriging and traditional ecological knowledge: the visual politics of uranium exploration in Arctic Canada' Chair: Noortje Marres (Goldsmiths)
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17:30-18:30	**Closing discussion** LT4	Anne Beaulieu (Virtual Knowledge Studio) and Paolo Quattrone (IE Business School)
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Friday 25 March 2011

Keynote 1

10:00-11:00 , Lecture Theatre 4

Steve Woolgar: ‘Visualisation in the age of computerisation’

This paper introduces and discusses the main themes of the conference. It reflects on changes in visualisation media in recent years and considers some of the implications of these changes for research. In particular, the paper discusses the “lure of the visual” – our tendency to experience visual representation as more “vivid”, “real”, “striking” than other media – and the consequences for our research. In what ways and to what extent can we resist being drawn in by the visual? How can we maintain analytic distance on the visual? What after all is “cool” about visualisation?

Paper session: Visions of evidence

11:30-13:00, Lecture Theatre 4

Chair: Alex Soojung-Kim Pang (Microsoft Research Cambridge)

Catelijne Coopmans (National University of Singapore): 'Visual analytics: witnessing artful revelation in business intelligence'

In recent years, business intelligence has been construed as ‘in need of’ the visual. Organisations, so the story goes, already see the importance of collecting electronic data on almost everything they do, but need to get better at extracting business value from these data. *Visual analytics* (VA) is the practice of exploring salient relations in large datasets with the help of on-screen interactive visualisations of trends, outliers and other patterns. Prospective users of VA software are promised a new way of ‘seeing-with-data’ that leads to business-relevant insights otherwise hard to obtain.

In this paper, I ask what it means to ‘see’ according to visual analytics. I argue that this question is usefully approached by studying how VA is made available for witnessing in the course of software demonstrations. In these instances, ‘the visual’ is mobilised in relation to expectations regarding both (epistemic) *truth* and (commercial) *value*. My analysis concentrates on one particular type of software demonstration: online web seminars structured around real-life examples of VA use. Organised by software vendors and featuring experienced user-analysts from a range of sectors and industries, these webinars draw on the notion of visual *revelation* – audiences ‘seeing for themselves’ – in both their content and their form. Yet witnesses are also made aware that the process of insight-development demonstrated in the webinars is (1) conditional on the skill of the user-analyst rather than automatically obtained with the software, and (2) incomplete in its approximation of the real thing, due to the absence of – among other things – real data. Through the interplay between what can be seen and what must be assumed, truth and value are drawn together in a way that is both pertinent to visual analytics and of relevance to the conceptualisation of new software-based visual practices more generally.

Emma Frow (University of Edinburgh): 'In images we trust? Setting guidelines for digital image processing in scientific journals'

This paper seeks to discuss notions of objectivity and practices of representation in the digital age by engaging with a contemporary debate in scientific publishing. Over the past decade, editors of several leading science journals have expressed growing concern about the use of digital image-processing software in preparing images for publication, particularly in sub-disciplines of biology including cell biology, molecular biology, and genetics. The ubiquity of software such as Photoshop now means that digital images of experimental results (obtained, for example, through microscopy) can be 'cleaned up,' 'beautified,' or otherwise transformed with 'a few clicks of the mouse' (Pearson 2005: 952). Notwithstanding its ability to yield aesthetically pleasing images, the rise of digital image processing is seen by some as threatening the credibility of images in research papers. Expressing concern not so much with intentional fraud, but rather with 'innocent' and routine digital alteration of images, several high-profile science journals - including *Science*, *The Journal of Cell Biology (JCB)*, *Proceedings of the National Academy of Sciences USA (PNAS)*, and the *Nature* family of journals - have recently introduced guidelines for authors concerning image manipulation, and are implementing in-house procedures for screening submitted images, including the hiring or training of 'forensic experts' to detect inappropriate image manipulation.

These efforts to develop guidelines and monitoring processes offer an interesting case study for exploring contemporary understandings of representation in relation to digital imaging technologies. Indeed, such actions might be seen to reflect a new moment in the trajectory of objectivity as a guiding value in image-making. What do the recent journal interventions suggest about the 'methods, morals and metaphysics' of digital image processing (Daston & Galison 2007)?

Editors are concerned with what they see as a crisis of trust, nominally brought on by digital imaging technologies, and their guidelines are presented as an intervention to help restore this trust (Editorial 2006: 892). Image-processing software offers new sites and possibilities for engaging with practices of image production, ones that can be seen to challenge the distinction between representation and intervention. In practical terms, the journal guidelines can be seen as an attempt to establish community norms and to 'draw a line' for the scientific community regarding acceptable and unacceptable practices in image preparation. However, in attempting to define simple, best-practice guidelines for digital imaging, journals must contend with a number of longstanding and complex issues regarding the role of images in the production and communication of scientific knowledge. Their editorials and commentaries make links between scientific virtues, practices of image production, the instrumental functions of images in scientific publications, and more theoretical concerns about the nature of visual representation.

Through their guidelines, I suggest that journals raise and must negotiate four interrelated issues relevant to published images: the relationship between image production and image processing; the line between appropriate and inappropriate manipulation; the relationship between the author and reader of a journal article; and the meaning of objectivity in the digital age. In this paper, I will outline the image-processing guidelines being developed by a number of leading journals, and explore the rationale for these measures as presented in their editorials and commentaries. I then consider how this contemporary debate relates to research from the history and sociology of science concerning ethics and objectivity in practices of preparing and using scientific images. By and large, the guidelines currently being developed stress the separation of 'aesthetic' from 'scientific' practices, and treat the authenticity of an image as key to its objectivity. These ambitions resonate with Daston and Galison's description of mechanical objectivity, but encounter some tensions given the availability of increasingly complicated and interactive methods for digital image production.

Erin Kruger (University of Western Sydney): 'Visualising uncertainty: law, DNA, and the quantification of "reasonable doubt"'

The idea of uncertainty in the adversarial system of criminal law has most frequently been captured in the standard of proof: ‘reasonable doubt.’ Whether judge or jury, those responsible for adjudicating an accused must attain a ‘satisfied conscience’ that the quality and quantity of evidence presented in trial renders a high degree of certainty that an accused is guilty of a given crime. Traditionally, judging guilt or innocence has depended on jury evaluations of testimony, the number and integrity of witnesses, their skill at presenting evidence, and its agreement with circumstances. The criminal law’s emphasis on DNA evidence in the last decades, however, is able to challenge the deeply historical assumption that the accused constitutes an uncomplicated corporeal entity that must face the procedures of law physically. The rise of DNA as a crucial instrument of criminal identification translates the idea of bodily corporeality into a molecular phenomenon represented by visual images. These images are further rendered into abstracted probabilities representing a ‘match.’ From an unknown crime scene sample that starts from potentially immeasurable contexts, forms, ages, places and sources, the practice of forensic DNA analysis takes this original unrecognizable bodily matter and transforms it through technological and scientific procedures to produce clear, coherent graphs, charts and profiles destined to link an unknown bodily source to a known one – the ‘accused.’ Yet, in the forensic laboratory, DNA is understood to be active and highly malleable; the biochemical nature of DNA molecules allows them to bond, change forms, react, endure variable temperatures, convert from purely biological to synthetic material, and to be represented visibly and statistically. I argue that the measure of certainty sustaining reasonable doubt has shifted from that of the ‘moral certainty’ assumed to guide a ‘reasonable person’ to the scientific processes found in forensic laboratories and the subsequent mechanical visualization of DNA as charts, graphs, and probabilities claiming to ‘match’ unknown and known biological samples. What informs decisions of guilt or innocence are now influenced by the quantifiable, coherent and decipherable images. This is particularly evident by the criminal courts focus on the final results of the DNA profile at the expense of the historically assumed body of the accused, which is displaced through discussions of random match probabilities and abstracted scientific procedures that operate through conversions between states, properties, and machines. Reasonable doubt – which once depended on attaining a certain degree of ‘moral certainty’ – is now replaced, or at least challenged, by the quantification of certainty and uncertainty exemplified in the production of DNA evidence.

Paper session: Philosophy of visualisation

11:30-13:00, Seminar Room A

Chair: Willard McCarty (King's College London)

Annamaria Carusi (University of Oxford) and Aud Sissel Hoel (NTNU): 'The measuring body: beyond quantitative/qualitative boundaries'

The emergence of the computational techniques of modelling, simulation and visualisation in all fields of science is producing a new range of visual artefacts for exploration, production of evidence and communication between disciplines. These techniques are forcing us to re-think the role of instruments and technologies in scientific vision, including perception and observation, and in the design, construction and sharing of visual outputs. More than that, computational visualisations and simulations challenge the long-established distinction between quantitative and qualitative methods in science, in that they seem to blur the boundary between, for example, statistical methods on the one hand and observational methods on the other. The dismantling of this distinction is a central theme in computational biology, the case which we discuss in this paper.

Computational techniques in biology are highly dependent on an impressive array of visual artefacts including microscopial images, MRI and fMRI, organ atlases, virtual organs, optical imaging of 'real' organs, and animated visualisations of simulations. It is not an exaggeration to say that the map of biology as a research area is being redrawn primarily through these visual artefacts, and the way in which they are used for evidence and communication. Disciplinary groupings within the broad domain of computational biology often define themselves according the two broad groupings of qualitative experimental methods and quantitative computational methods. However, the use of visual artefacts within and across different groupings does not bear this out. By blurring the quantitative/qualitative distinction, the new configurations of visual artefacts simultaneously blur the boundaries of the different groupings and the boundaries of the field of biology itself. Computational biology is an excellent example of computational science where hybridisation is occurring, as instantiated especially through visual artefacts and observational and other visual modes through which much of the science is carried out. Our case study gives a detailed account of this hybridisation process, where new configurations of vision, technologies and objects (ranging from biological processes to mathematical ideas) arise. We will argue that the computational mediation of these objects and their possible inter-relations with subjects demands a reframing of the methodological qualitative/quantitative distinction and of the ontological subject/object distinction on which it is based. The process of developing a model involves quantification and mathematisation at every step, although each step is also accompanied by images and visualisations, including in the final rendering of a simulation in qualitative visual form. The transmutation of the quantitative and the qualitative in the experimental workflow occurs at several crucial moments. In this paper we will focus on a key point in this complex process: the construction of the computational mesh which is used in the software that drives the animation, and onto which any particular simulation is mapped. The construction of the mesh is pivotal to the whole process of modelling and simulation, since the mesh needs to answer to the research question that the model is trying to address, and at the same time it is the very means whereby the model and simulation can be visualized. The mesh is a mediator between qualitative and quantitative, not simply in that it negotiates them, but in that it intertwines them.

This paper turns to the late work of Merleau-Ponty for an ontological framework that may prove helpful for understanding how computationally mediated scientific vision operates. In particular we focus on his adoption of the notion of the circuit from the biology of Jakob von Uexküll, and his idea of the measuring body, which immediately brings the quantitative and the qualitative into a new, and now internal, constellation. We argue that using this biologically inspired framework allows for a new way of thinking of computationally mediated vision.

Victoria Höög (Lund University): 'The epistemic perspective revisited: Quine's thesis of holism and underdetermination applied to visuality in the sciences'

The great results achieved by STS should not hamper to examine what conceptual resources philosophy offers for an analysis of epistemic realism in scientific visuality. A suggestion is that W. van O. Quine's thesis about the holism and underdetermination of theory might be helpful devices for analyzing scientific computational generated pictures. Quine's holism aims to hold for all branches of sciences including mathematics . Holism can be interpreted as the thesis that evidence rest on theories as wholes and not on individual parts of a theory. Hence, in general scientific pictures lack a secure empirical content taken in isolation from another. But conjoined into series of pictures or corpus of pictures, the depictured phenomenon has an empirical content. Underdetermination can only obtain for complex theories, which are not empirically warranted. Taken together with the underdetermination thesis i.e. that observations alone do not determine theory; holism can be used for at the same time acknowledging a theory's fallibility and preserve a scientific realism .

In his last versions of underdetermination thesis Quine asserted that it was a confusion to suppose that we can stand aloof and recognise alternative ontologies as true . Truth is immanent and there is no higher. Of course one should have an epistemic openness depending on the evidence situation, but we can't encompass different ontological versions of reality. In most scientific fields the scientists can return to the observational or experimental level, and reconstruct the algorithms behind.

In molecular protein biology after the crystallisation process is successfully done the measured density between electrons are modeled into pictures in order to grasp the where the atoms are sitting in the molecule .The next step is to apply another pictorial model, a structural model in order to find the specific shape of the protein molecule at display. The pictorial and animation programs are research tool, designed by professional researcher. The choices of colors are not standardised as the colors works as explorative devices in order to find to the best final model that matches density and structure. The pictures are necessary tools on the way to find out the protein structure and the molecules. A conclusion is that the visual representation aims at shaping and strengthening the standard of objectivity by combining two depictured aspects of the molecule, the density- and the structural models.

Some conclusions are 1) The visual representation has holistic connection to reality in the Quinean sense, though originally beyond our senses. 2) Scientific realism is still a valid position and hence the quest for objective truth. 3) Despite the pervasive computerization of scientific imaging, traditional concepts such as objectivity and realism are still valid connotations, however in new constellations.

Nicola Mößner (RWTH Aachen University): 'Are visualisations a link to nature?'

An important feature of computer-aided sciences is to make the unobservable (i.e., *with the naked eye* unobservable) observable. A consequence of this seems to be that the sciences comprise more and more of abstract or even dubious objects. Are those objects, which are only visible with the aid of instruments, real or mere artifacts, i.e., products of the theory at hand or of the scientist's wishful thinking? This is no new question as it lies at the heart of the debate between scientific realists and anti-realists. Realists, like Richard Boyd, describe their position as follows: "Scientific realists hold that the characteristic product of successful scientific research is knowledge of largely theory-independent phenomena and that such knowledge is possible (indeed actual) even in those cases in which the relevant phenomena are not, in any non-question-begging sense, observable" (Boyd 2002). Contrary to this, scientific anti-realists, like Bas van Fraassen and others, are skeptical about theoretical terms and unobservable entities connected with them. Van Fraassen, for example, is of the opinion that all a scientist can long for is an *empirical adequate theory*. We do not speak about true or at least approximately true theories any longer, because we are not able to find out whether the theoretical components that are not testable via observation are correct or not. In this sense they can be put aside as they are of no further epistemic value – let alone to think of them as real entities in the outside-world.

Although the question concerning the distinction between the observable and the unobservable is therefore by no means a new one, recent developments in the era of scientific visualisations added new fuel to the debate. The problem is that we do not only have to deal with theoretical terms but also with *theoretical images*. The unobservable has become a little bit visible but not visible enough, so to speak, for a clear judgment about its existence. Computer-aided visualisations are common means in scientific practice nowadays. Nevertheless, philosophers of science are still arguing about this practice.

The problem seems to be that visualisations can be manipulated to enhance our understanding of special features of the depicted object. As a consequence of this, the question arises what the depicted entity *really* looks like. Where does reality end and where does the theoretical construction begin? Do we really know that such and such properties belong to the depicted entity or not? For illustrating this point, we can take a false colour photograph of "Olympus Mons" on Mars (http://www.dlr.de/mars/en/desktopdefault.aspx/tabid-4677/7747_read-11947/gallery-1/gallery_read-Image.8.5155/). The picture shows the highest volcano in our Solar System. It is a photograph made by the HRSC (High Resolution Stereo Camera) integrated in the orbiter "Mars Express". But it is no ordinary photograph as its colours (range from blue to red) are artificially added to accentuate the different altitudes. Those colours are, of course, not the true colours of "Olympus Mons". Nonetheless, they are related to real properties of the mountain, namely the different altitudes, a feature that may be simply overlooked in all its details when observed with the naked eye.

The aim of my talk will be to defend the thesis that, from the perspective of a scientific realist, visualisations can be hints for the existence of an otherwise unobservable object. Mostly they depict special properties which are of interest for the scientist. Furthermore, we can combine this with a causal theory of images as it seems right to hold that *if the entities were different, their visual representation would also be different*. But this does not mean that the entity would look in the same way as its visualisation does, if we were able to observe it without the aid of instruments. To put it in a nutshell, the thesis is that arguments in favour of scientific realism can also be used to defend a realistic interpretation of scientific computeraided visualisations.

Paper session: From vision to interpretation

11:30-13:00, Andrew Cormack Seminar Room

Chair: Michael Batty (University College London)

Richard Arias-Hernandez, Tera Marie Green and Brian Fisher (Simon Fraser University): 'From cognitive prostheses to cognitive amplifiers: understandings of the material basis of cognition in visual analytics'

Defined as “the science of analytical reasoning supported by interactive visual interfaces” (Thomas et al., 2005), Visual Analytics is a post -9/11 techno-scientific endeavor. Its research agenda was drafted in 2004 by visualization researchers from academia, industry, and government labs on the request of the US Department of Homeland Security. The initial objective of visual analytics was to address analytical challenges in intelligence analysis and public safety posed by the threat of terrorism and natural disasters. As dramatically illustrated by the events of 9/11, intelligence analysis failed to connect the dots among dispersed yet available, information, which, if appropriately considered, could have prevented those attacks in the US. In retrospect, this weakness in intelligence analysis was explained in terms of the human and technological inability to cope with the information overload produced by enormous amounts of constantly generated, intelligence-related data.

During the first years of development of Visual Analytics (VA), researchers concentrated their efforts in the development of computationally-based, interactive, visual representations as well as on the development of several assumptions about analytical cognition during visual analysis (Pirolli, 2005). The foundational assumption in VA is that, in contrast to computation alone, visualization can harness the human mind’s innate “visual intelligence” to gain novel insights into situations characterized by complex data that may contain uncertainty in fact or relevance to the problem, or time and location of occurrence. In the process, at least two kinds of “augmentation” of cognition were theorized.
The first kind emphasizes visual representations as the material basis for augmentation of cognition. By developing computer representations of data that are designed to trigger instinctive perceptual responses, visual analytics creates systems that offload cognitive, high-order processes, such as comparing values or detecting outliers, into the more basic pre-cognitive, sensorial system (Card et al., 1999). For example, visually marking outliers with different colors, shapes or sizes. This kind of augmentation of cognition emphasizes visualization as an external representation, which is coupled with the analyst’s internal knowledge representations.

The second kind of augmentation of cognition emphasizes interaction or interactive techniques as the material basis. By creating interactive visualizations, visual analytics can allow the analyst offload some smaller cognitive processes, such as juggling the memory of multiple search results or annotating the strength of a relationship between two visualized concepts into what are essentially outputs of the motor system (e.g. saving the state of an analytical process or creating annotations about the reasoning process). These artifacts of interaction can be both real-time, as musing behaviors and menu interaction, as well as asynchronous, such as when an analyst creates notes for future use by herself or by other analysts who will use the visualization afterwards.

In our paper we discuss how these two kinds of cognitive augmentation have provided the ground and the assumptions in visual analytics for their two corresponding “cognitive artifacts” (Norman, 1993): visual representations of abstracted data and interaction techniques. We also discuss the problem of agency in these understandings since arguments of cognitive augmentation differ in how the cognitive agent is conceptualized. For example, mainstream cognitive models in visual analytics assume a homogeneous, universal, and rather passive cognitive agent that couples with visual analytic systems to augment her cognitive skills (Liu et al, 2010). A consequence on this has been the establishment of monolithic/universal cognitive models in this discipline extracted from the domain of intelligence analysis (Pirolli, 1999, 2005).

More recently, however, research in the cognition of visual and spatial representations has challenged this view showing that cognitive agents display a wide variety of cognitive behaviors when interacting with visual analytic systems (Keehner et al., 2008). This expression of heterogeneous, situated, and active cognitive agents that negotiate the terms of its coupling to external representations and interactions problematizes the established cognitive science ideas when applied to visual analytics. Finally, we discuss how the deeply embedded monolithic model of cognition has impacted on the design and evaluation of current technological systems in visual analytics, and possible alternatives to diversify this mainstream technological style to incorporate the more recent perspectives of situated, heterogeneous, and active cognition.

Min Chen (Swansea University) and Luciano Floridi (University of Oxford and University of Hertfordshire): 'An information map for visualisation'

Visualisation is a form of 'computed-aided seeing' information in data. As a technical term, 'visualising' refers to different aspects of a visualisation process, primarily in two semantic contexts:

- Viewing – *Making visible to one's eyes*. This is concerned with the process of specifying meaningful or noteworthy information, creating appropriate visual representations, and conveying visual representations to viewers.
- Seeing – *Making visible to one's mind*. This is concerned with viewers' thought process and cognitive experience of interpreting received information and converting the information to mental representations of what is intended to be conveyed by the information.

These two contexts correlate to different parts of a visualisation pipeline. In the former context, we focus on the parts of a visualisation process that are mediated by the computer. These include computational algorithms for filtering, visual mapping and rendering, as well as display systems and user interfaces. In the latter context, we attempt to optimise the usefulness and effectiveness of a visualisation process. Issues addressed in this context typically include creation of visual metaphors, design of visual representations, and evaluation of visualisation results and user experience.

Information is the fundamental `currency' being passed around within a visualisation pipeline. In this paper, we consider two formal theoretic frameworks of information, and their potential in offering answers to some of the questions posed in the Call for Papers.

The most well known formal theory of information is Shannon's information theory, which provides a framework for quantifying information, and optimising information coding and communication. Recently, Chen and Jänicke found that information theory can explain many phenomena in visualisation processes, including overview zoom details interaction, logarithmic visual design, and use of motion parallax in volume visualisation.

In philosophy, there have been some studies on the theory of information, but rather scarce in comparison with its companion subject epistemology. Floridi studied the various forms of information, and established a taxonomic framework for categorising information and its semantic contents. In this work, we apply this taxonomic framework to visualization, with the aid of information theoretic measures.

Ségolène M. Tarte (University of Oxford): 'The interplay of visual perception and cognition in digital papyrology: visualisation for interpretation, visualisation as interpretation'

Digital papyrology (or computer-assisted papyrology), is the modern study of ancient documents (including papyri, wooden Roman tablets such as the Vindolanda tablets, etc), from their deciphering to their interpretation with the support of digital tools such as digitised versions of the documents (ranging from photographs to 3D models) and software that provides annotation capabilities, image processing tools, and access to contextual information and various other relevant resources (palaeographical data, dictionaries, indices, etc...). As such, digital papyrology encompasses the digitization of the documentary artefact and the digital support provided for its interpretation.

Digitisation is never neutral and, in this paper, I present how the act of digitising an artefact is influenced by intrinsically intertwined visual perception and cognition. I further argue that, performing the act of digitisation by digitally replicating the methodologies that experts deploy, the resulting digital representation of an ancient document expresses a certain from of presence of the artefact, making that visualization of the artefact an avatar rather than a surrogate of the artefact, and thus blurring Saussure's signifier-signified distinction.

Papyrology: an interpretative practice

Through ethnographic observation of papyrologists at work, I have identified two (non mutually exclusive) interpretative methodologies (Tarte, 2011). The first approach, the Kinaesthetic Approach, consists of tracing the text. This approach effectively supports the experts in establishing a feedback loop between "seeing that" and "seeing as" (Wittgenstein, 1953), between the mental image of the text and the textual artefact. In that sense, the act of drawing to inform and build an interpretation inscribes itself in an embodied model of cognition, where a specific physical activity is an integral part of the cognitive process (Shapiro, 2010). The second approach, the Cruciverbalistic Approach, imitates crossword puzzle solving. It allows the experts to reason about hypotheses of interpretation in an epistemological framework in which pieces of evidence towards hypotheses of interpretation are evaluated as with a crossword puzzle (Haack, 1993; Roued-Cunliffe, 2010). This approach inscribes itself more in a connectionist model of cognition, where context is key to the outcome, where identification of a word conditions the identification of a character (McClelland and Rumelhart, 1981). In both cases, the text continuously oscillates in the expert's mind between shape and meaning, tightly intertwining visual perception and cognition. Overarching those two approaches, throughout the interpretation process, and additionally to recursion (Youtie, 1963; Terras, 2006), uncertainty plays a key role (Tarte, 2010). I illustrate the importance of uncertainty with the example of a Roman stylus tablet that was interpreted twice ninetytwo years apart. This uncertainty occurs pervasively, and must be catered for in particular at the stage of the digitization of the documentary artefact. When digitizing the artefact, transposing the real-world strategy of the experts digitally is crucial. It enables to incorporate explicitly the implicit elements of interpretation inherent to the visual inspection of the document with intent to interpret it. An example of such an imitative digitization strategy is shadow-stereo combined to Reflectance Transformation Imaging (Malzbender et al., 2001). Another example of imitating the functioning of the visual system, this time when identifying the text features on a digital image, is Phase Congruency (Oppenheim and Lim, 1981). Mimesis of the expert process is our guiding principle when developing digital support for papyrology.

What is a digitized artefact?

Having detailed some of the aspects of digital papyrology, in particular of artefact digitization, and how we have proceeded in the framework of the e-Science and Ancient Documents project1, it is legitimate to ask: what is a digitized documentary artefact? By nature it is a visualization, or rather, a visual representation of the artefact. Its digital nature often confers on it a sense of scientific legitimacy and thereby of exactitude that could be detrimental to the interpretation-powering uncertainty. The way the images are captured, however, are dictated by an implicit model of what is expected from the artefact. Expectations influence strongly the digitization strategy, and the act of digitization is already an intrinsic part of the interpretative process. The textual artefact is digitized both for future interpretation and as it has already been implicitly interpreted. In that sense, there is no optimal digital representation of an artefact, optimality can only be gauged and reached when the intention for digitization is explicit, contextualized. A digital representation of an artefact only expresses some facets of the artefact, those that the expert sees as salient and relevant when establishing a digitization protocol. Like in the Ancient Assyrio-Babylonian concept of visual representation (‘s.almu’), of image, I would argue that one could describe digitized artefacts as ‘s.almu’, with the following ontology : “(...) visual representations might be encoded, but they are also embedded into the real and have an influence on it as mantic” (Bahrani, 2003). In other terms, like a ‘s.almu’, a digitized artefact is one form of presence of the physical artefact, and its “mantic influence” on the artefact pertains to the support it provides to interpret it, as intended at digitization time. So that, a digitized artefact is more an avatar of an artefact than a digital surrogate, as it is often called in the literature. By taking on board the strategies of interpretation when performing a digitization, the resulting avatar of the artefact already encapsulates some form of presence, some form of meaning, some form of interpretation of the artefact. It’s an Assyrio-Babylonian ‘s.almu’, that blurs Saussure’s signifier-signified distinction.

To conclude, papyrology is an intrinsically interpretative discipline drawing heavily on embodied and connectionist mechanisms of cognition and fuelled by uncertainty. These processes are also present in digital papyrology as digital tools are built by and for papyrologists. When digitizing the textual artefacts in particular, one always implicitly (or explicitly) incorporates the intention behind digitization and the intention in papyrology is to interpret the artefact. These embedded digitization variables make a ‘s.almu’ of the visual representation of the artefact, expressing a certain form of presence of the artefact that also influences the artefact, significantly blurring the traditional signifier-signified divide.

Paper session: Visualising networks

14:00-15:30, Lecture Theatre 4

Chair: Felix Reed-Tsochas (University of Oxford)

Sarah de Rijcke and Anne Beaulieu (Virtual Knowledge Studio): 'Network realism: making knowledge from images in digital infrastructure'

The label of age of computerisation evokes a number of cultural shifts with regards to visualisation. Besides the growing importance of entering, processing and storing information in computer systems, the intersection of digital technologies and electronic networks is increasingly shaping both specialist and everyday visual culture (Mitchell 1992; Lister 995; White 2006).This paper will specifically focus on epistemic practices taking place around networked databases of digital images. At the intersection of digital technologies and electronic networks, images can be related to each other, within databases or with many other resources on the web, and they serve as support for mediated social interactions such as discussion, annotation, or photo-sharing (de Rijcke and Beaulieu 2011). The intersection creates contexts in which digital images are more portable, more spontaneously produced, or more easily translatable across technological platforms. Comparing, producing, sharing, annotating, searching, and viewing such images are increasingly important epistemic strategies.

This is the case in the context of brain scans, which have been in heavy circulation these past 20 years as some of the most fascinating and ubiquitous digital images in scientific and cultural spheres. In this paper, we analyse how the scans are both digital and networked images that depend on suites of technologies (Shove et al 2007) for their constitution and meaning. In particular, we will show how the production and reading of brain scans function in different suites, some of which reinforce a modernist, mechanical, ‘pipeline’ approach to brain imaging, where digital images are acted upon as measurements, and others that highlight the interactive and interventionist potential of digital imaging, where brain scans are constituted as fluid animations. We argue that brain scans come to be associated with specific kinds of authority through complex ecologies of representational routines in digital visual culture. In particular, brain scans are focal points in arrangements of scanning and database technologies, constituted in electronic networks where individual experiences are mediated by interfaces. New modes of seeing and novel technologies co-evolve with adjustments in particular epistemic approaches, at times resembling earlier practices and at times moving towards new kinds of objectivity.

Our analysis will show how the authoritative status of these scans is enacted through relational processes of interaction, correlation, personalisation, annotation, and circulation-remediation. These processes are the result of important differences between images constituted through cascades of inscriptions (Latour 1990) and those produced through the alignment of networked infrastructure and images as interfaces. The paper will shed light on the meaning of these images as the outcome of distributed actions that are social and technological, and involve not only the viewer and the image (Gooding 2004; Daston and Galison 2007), but also databases and networks. In these contexts, the way images take on instrumental and authoritative roles remediates (Bolter and Grusin, 2000) tradition and supports new practices around visual knowing. In other words, we will show that networked databases of digital images are important sites for knowledge production, since they not only shape the objects that are made visualized but also how the value of images is performed.

Our contribution will engage with areas of scholarship concerned with the history of realism (Coyne 1999; Stafford 1996) and objectivity (Beaulieu 2001, Daston and Galison 2007, de Rijcke 2008), and with STS due to its concerns with epistemological and ontological issues and with knowledge in networks (Carusi forthcoming; Mackenzie 2003; Kwa 2005) and databases (Hine 2006).

Anders Koed Madsen (Copenhagen Business School): 'Delineation devices at the root of social representation - a comparison of online entry-points for mapping the controversy about synthetic biology'

People are currently leaving an unprecedented amount of information on the web in the form of tags, tweets, links, blogs-posts, wikis-entries etc. Web-languages and technologies such as HTML, Java and Ajax have contributed to this rise of usergenerated content and different branches of the social sciences are currently pondering the potential of using of this kind of data as a way to understand the society we live in (Latour, 2007; Lazer et al., 2009; Manovich, 2009; R. Rogers, 2009). This ambition has led to the development of a broad range of software packages aimed at mining digital data and one strategy for using this kind of software to visualize social dynamics has been to ´follow the web´ and its own logics for making information visible. The rationale of this methodological strategy is to take advantage of the unique filtering mechanisms on the web that may make aspects of society visible that traditional social scientific methods misses. As Richard Rogers puts it, “We look at Google results and see society instead of Google”(Rogers, n.d.).

This paper focuses on the potentials and pitfalls of using “the logics of the web” to make controversies around ´synthetic biology´ visible. It proceeds by following the organization of information on entry-points to the web that align them-selves with the frequent claims made about the democratic ethos of collaborative filtering on the web (e.g. Benkler, 2006; Shirky, 2008). The entry-points chosen as cases are Google, Technorarti and Wikipedia[1] and the paper explores the way in which controversies about ´synthetic biology´ are made visible in these distinct web-spheres. The methodological approach is to compare visualizations that result from running at structural and semantic network analysis on central actors and concepts in each of them.[2]

The pilot-study of the paper demonstrates that the web is a fragmented space and that different entry-points make radically different assemblages visible in relation to the controversy about ´synthetic biology´. They ´delineate´ the controversy in different ways and they give rise to ´web-ecologies´ that differ in the way they demarcate relevant information and the kind of expertise they highlight. Each web-ecology can be seen as an assemblage of the algorithm behind the search-engine, the actors that become visible in the ecology and the technologies enrolled in the discussion and each webecology give rise to networks that visualize the controversy about synthetic biology in different ways. This leads to the question of whether there is anything new in this form of computational seeing? Does the web allow us to see publics and socio-technical networks around the controversy of ´synthetic biology´ in new ways? To answer this question the paper will supplement the comparison of web-ecologies with an analysis of the way this controversy is “made visible” in reports based on traditional methods for synthesizing information such as stakeholder-meetings and citizen summits.

In connection with this question there is a need to ponder what kind of theoretical language that can be used to interpret the kind of visualizations that the analysis produces. The paper argues that computer visualizations can help bridge the distinction between quantitative and qualitative research and it does that by merging the vocabularies of ‘Social Network Analysis’ (SNA) and ‘Actor-Network Analysis’ (ANT). The relation between SNA-concepts such as ‘brokers’, ‘central actors’ & ‘clusters’ (Hanneman & Riddle, 2005) and ANT-concepts such as ‘obligatory passing points’, ‘associations’, enrolment’ & ‘macro-actors’ (Callon, 1986; Latour, 1991) is emphasized and it is argued that the quantitative approach of SNA might serve as a fruitful startingpoint for a more qualitative ANT analysis. Combining a quantitative SNA-analysis with a qualitative analysis of connections also allows non-human actors to enter the picture and the paper will illustrate how this combination can be fruitful in relation to generating knowledge about the way web-ecologies assemblage the social by enrolling actors and by giving rise to specific problematizations around ‘synthetic biology’,

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[1] See for example: http://www.google.com/corporate/tenthings.html, http://technorati.com/state-of-theblogosphere & http://wikimediafoundation.org/wiki/Home

[2] The visualizations were made using the Issue-Crawler (http://www.issuecrawler.net/) and UCI-net (http://www.analytictech.com/ucinet/) to conduct the structural hyperlink analysis and and Leximancer (https://www.leximancer.com/) or Wordstat (http://provalisresearch.com/wordstat/Wordstat.html) will be use to conduct the semantic analysis.

So, by taking a specific case as the point of departure – the controversy about synthetic biology – the paper provide answers to three questions. The first question is whether the method of following digital traces on the web can enable a new form of computational ´seeing´ in relation to bio-technological controversies. The second is whether different web-ecologies allows for different ´eyeballs´ and the third is whether the visualizations can function as an occasion for cross-fertilizing quantitative SNAconcepts with qualitative ANT-concepts in the study of social dynamics around emerging technologies.

Albena Yaneva (University of Manchester): 'Moving networks: architectural tools for tracing the social'

Recent collaborations at the crossroad of the fields of science and technological studies and web technologies have led to numerous novel attempts of visualizing networks. Yet, all the network maps at our disposal suffer from two main deficiencies: 1) although based on dynamic web browsers, the final maps are static and difficult to manipulate and update; 2) their visual repertoire draws on a rather limited graphic language; in a technological and visual sense a network map is often a chart made of dots connected by lines. That is a rather "anaemic" representation, as suggested by Peter Sloterdijk's, in opposition to his concept of sphere.

How can these static and "anaemic" visualizations of networks be overcome? How can networks be more efficiently presented to avoid the traditional separations between actors and network, between individual and society? How can connections be better pictured without pre-defining the essence of the actors enrolled in a network? What kinds of time-space dimensions are deployed in a network map? What paths between primary data and analytic maps could be made possible? To answer these questions, I suggest drawing on the expertise of a discipline, which has benefited for years from exceptionally good and versatile visual tools – architecture. Taking advantage of the new developments of architectural software, I explore alternative ways of digital data analysis and present visualisations in which the actors gain identity *only* in a network and are capable of infinite multiplication in the process of enquiry; time folds and unfolds with changing and reversible paces of speed; the maps are dynamic and can be swiftly updated.

Paper session: Filmic realities

14:00-15:30, Seminar Room A

Chair: Javier Lezaun (University of Oxford)

Pål Aarsand (Uppsala University) and Anna Sparrman (Linköping University): 'Visual transcriptions as theory (and methodology)'

More than 30 years has gone since Elinore Ochs (1979) problematized transcriptions in here widely known article ”Transcription as Theory”. In this article, Ochs emphasizes that transcriptions of audiotapes are done with regard to: theoretical stances, research interest and purposes of the study. Thereby, she underlines that transcriptions is not a mirror of the activity that we study, but the result of a processes of choices done by the researcher(s).

The idea behind transcriptions especially within Ethnomethodology, and Conversation Analysis is to give the reader a ”kind of ’independent access’ to the data being analyzed” (ten Have 1999, p. 33). Thereby, the importance of transcribing is underlined as a question of research validity where the idea is to make the relation between transcriptions and analysis transparent. During the last 30 years transcription methodologies have changed and developed and an extended literature on issues surrounding transcriptions of audio- and video recordings have developed (Bucholtz 2000; Goodwin 2000; Hammersley 2010; Linell 1994; Lynch 1990; ten Have 1999; Silverman 1997). Due to this technological development, researchers within the field of social studies now use video cameras in the study of situated practices. In line with the question of transcribing, this has generated discussions about what kind of data and knowledge that are created (Heikkilä and Sahlström 2003; Sparrman 2005; Aarsand and Forsberg 2010). When transcribing the visual material the same concerns Ochs raised 30 years ago are at work: why are the transcripts made visual? What is the theoretical stance for the transcription conventions and what is the purpose of visualizing the transcriptions? Thereby, it is also highlighted how video data is created trough series of choices for practical purposes. Based on the increased use of digital video recordings and the increased mix of visual and audible material in research articles, we study how and what is gained by using visual data, and the ontological status given to it.

New technology has made it possible to communicate by putting together different media (text, pictures, drawings, etc.) or to put it differently, it has made it possible to create new assemblages within research publishing. During this process, we argue, most researchers try to fix the meaning of the finale product by using a certain kind of ‘form’ (Latour 2005). Inspired by Bowker & Star (1999) we use the concept “boundary object” to focus on how researchers try to fix meanings in research publishing. In addition, we make use of Karen Barad’s (2006), idea of how the visual and the audio work as “boundary drawing practices” where phenomena are established as natural occurring. Research articles are then in this paper seen as mixed media (cf. Mitchell 2005) and remediation (Bolter and Grusin 1999).

The paper shows examples of visual transcriptions chosen from slightly different research areas and with different transcription solutions. All the transcribed material is based on video recordings which in one or the other way has been digitalised and transformed into new visual forms. The paper concludes that these new ways of transcribing seldom, or never, are problematized as research sources. We see two patterns in the way that visual data is used; first as a way to illustrate people in action but with no reference to the visual in the analyses, and second the visual as a possibility to increase the complexity of the research data that are analysed. Importantly is however that whether visual data are used as part of the analysis, or as illustrations that works as proof of an activity, the visual is more or less repeatedly treated as taken for granted and as an objective reality that the reader just has to accept. We argue that the interplay between transcribed audio and visual data construct an ”out-thereness” (Potter 1996). That is the idea that the neutral researcher is investigating reality as something that exists in the presented form independent of the researcher. As an example can be mentioned the process of describing movement in transcriptions with still pictures without problematizing this translation or transformation turning one visual (digital) data into another form of research material. To problematize the interrelationships between technology, visuality, the observer and visual values are also theories from the research field of visual culture used (cf. Crary 1990; Mitchell 2005).

Philip Brooker (University of Manchester): 'Videoing 'seeing' in the work of Astrophysics programming'

This paper seeks to analyse some preliminary findings from a video-based project looking at the work of programming as a tool for creating, developing and working with visualisations in astrophysics. This research consists of a video-based ethnography of a postgraduate student's (here called HR) project in astrophysics to develop and test a program to generate images from data then classify them as instances of gravitational lensing events (where the gravitational interaction of two stellar objects affects the electromagnetic radiation produced by both of them).

The video sequence being analysed shows HR working on improving the program by manually inputting information on the emission peaks of these objects. To understand the work of projects involving astrophysics concepts and phenomena, my own research has involved a considerable amount of preparation, involving attending lectures in (and learning) physics, astrophysics and mathematics, as well as following the work of doctoral students in the laboratory. What the integration of video recordings into this research enables is the capacity to look more closely (and repeatedly) at the various activities making up the work of astrophysics. This allows for a focussed understanding of how astrophysicists develop and adapt their research instruments, such as visualisations, for the purposes of their research. Essentially, with video it is possible to take a longer look at what astrophysics programmers have no reason to actively pause to look at – their routine work and the inherent order that it creates and is created by.

This project is situated in the field of STS, which has a well-established branch covering visualisations, programming, modelling and simulations (see Hackett *et al*., 2008, Knuuttila *et al*., 2006, Lenhard *et al*., 2006 and Lynch and Woolgar, 1990). My own work draws on ethnomethodology and conversation analysis, which has itself made noteworthy contributions to STS (see Button and Sharrock, 1995, Coulter and Parsons, 1990 and Rooksby *et al*., 2006 for example). Within this initial direction, the present paper attempts to treat 'computational seeing' as the outcome of a multitude of possible activities ('looking,' 'observing,' 'scanning,' 'examining,' 'searching for,' 'recognizing' and so on) (Coulter and Parsons, 1990). In order to understand what it is to 'see' computerised visualisations, it is crucial to look at the activities surrounding their development and usage. Moreover, as Rooksby *et al*. note, to appreciate the work of programming, "the ethnographer should benefit from some understanding of programming...In becoming a programmer you learn, among other things, to read code in the way that programmers should, can and do read code" (2006: 209-210). Consequently, some effort must be made to investigate such work in a context-sensitive way (which I argue would include both knowledge of programming languages as well as knowledge of the field and project for which the program is being developed – in my case, astrophysics), such that the content of the activities themselves are not removed from our accounts of them. Button and Sharrock (1995) make such an initial examination of the work of 'professional' programming (as opposed to 'hack' jobs which are rendered unusable to others by their lack of a self-explicating order). Button and Sharrock refer to how programmers use the temporary naming of variables and the visual organisation of written code as a resource for working out the programme. My own video research aims to review some of the practices involved in HR's 'professional' program-writing, paying attention to the way in which his software development activities are embedded in the practicalities of the wider research programme, involving HR in managing 'interruptions', altering the programming process for the purpose of adequate visibility, diagnosing errors, making checks on both obvious and ambiguous lenses, and so on. These are some of the recurring activities of 'professional programming' which make the data usable for the programmer and for other researchers. An analysis of this kind can thus provide a means of understanding what is being 'visualised' in an onscreen display, accessing 'computational seeing' through close analysis of the various activities that generate and construe an adequate representation of an astronomical phenomenon.

Alma Steingart (MIT): 'Unspooling the topologist's videotape: from chicken-wires to film festivals'

A sea change is underway in mathematics. Over the past four decades, mathematicians have begun advocating the use of visualization methods in mathematical research and education, not only "to bring the known mathematical landscape to life" but also to "obtain fresh insights concerning complex and poorly understood mathematical objects". The desire to bring mathematics "to life" is especially surprising when compared to mathematical modernism, defined by one historian of mathematics as "an autonomous body of ideas, having little or no outward reference…and maintaining a complicated—indeed, anxious—rather than a naïve relationship with the day-to-day world". The mathematicians who advocate the increased role of visualization in mathematics single out the advances made in computer technology—and computer graphics more specifically—as the crucial impetus behind this turn. In tracking this transformation, this paper examines the production of a mathematical video in early 1970s by mathematician Nelson Max. "Turning The Sphere Inside Out" represents one of the first attempts to use computer graphics to visualize mathematical objects and theories, which were otherwise hard to depict. The introduction of computer graphics into mathematics offers a test case from which to investigate how computational visualization functions not simply as a mode of representation, but also as a mode of experimentation, in work otherwise considered purely theoretical.

Nelson Max, head of the Topology Film Project (an initiative founded with NSF funding in 1970), produced the Project's most celebrated film, "Turning The Sphere Inside Out," which took six years to make and dealt with the sphere eversion problem in topology. Stephen Smale had proven a few years earlier that such an eversion was possible, and Max proposed producing a computer-animated film to show the transformation in real time. In his recollections, Max writes that when he proposed the project in 1969, he "had no idea how difficult a computer modeling, graphics rendering, and film production [he] was attempting". The project evolved from using "stop motion clay animation" to measuring "nickel-plated chicken-wire models of eleven key stages of the eversion" constructed by fellow mathematician Charles Pugh. In this paper, I claim this film was not simply a post hoc representation of a theory, but rather an animation of a theory that represented otherwise timeless mathematical concepts in time.

Brain Rotman has argued that "the effect of computers on mathematics (pure and applied) will be appropriately far-reaching and radical," affecting not only "changes in content and method," but also "altering the practice and perhaps the very conceptions we have of mathematics". Maybe so. Nonetheless, only a close historical account can identify the driving forces behind such changes. Analyzing (1) what inspired these mathematicians to turn to computer graphics in the first place, (2) how they understood the connection between the films they produced and the mathematical theories on which they were based, and (3) the way they were received by the mathematical community will illuminate the complex and historically specific relationship between computer visualizations and abstract formalisms in mathematical teaching and research.

Whereas science studies accounts of representation and the visual cultures of science primarily have focused their analyses on the natural sciences, a close investigation of computational visualizations of mathematical theories can contribute to recent accounts of how visualization techniques engender new conceptual objects, material practices, and experimental enterprises. Since the ontological status of mathematical objects is always up for grabs, mathematicians are often vocal about the relative abstractness or concreteness of their theories as they work to construct and maintain clear distinctions between the two. Paying close attention to these sorts of negotiations could illuminate the role of visualization and modelling as a creative scientific endeavor.

Paper session: Data intensity and visual knowing

16:00-17:00, Lecture Theatre 4

Chair: Ralph Schroeder (University of Oxford)

Andrew Hudson-Smith, Steven Gray, Oliver O'Brien, Richard Milton (University College London): 'Harvesting and visualising the crowd: Twitter space, bikes, surveys and data stores'

This paper describes how we are harnessing the power of crowd through Web 2.0 and related technologies to create new methods to collect, map and visualise geocoded data for e-Science. Crowdsourcing (Howe, 2008) is a term often used for methods of data creation, where large groups of users who are not organised centrally generate content that is shared. With the addition of a geographic element, this data becomes known as 'volunteered geographic information' which arguably is revolutionizing the way in which maps are created and used (Goodchild, 2007). This paper explores the development of a number of toolkits developed at the Centre for Advanced Spatial Analysis (CASA) to harvest the crowd and map any geographic related data. Our emphasis is on building a geospatial database and real-time rendering system to aid the social simulation and e-Science communities as well to provide geospatial services to the public at large. One of our toolkits 'SurveyMapper' is currently under development as part of the National e-infrastructure for e-Social Simulation (NeISS) project. In early beta, the system provides social scientists with a series of online tools to collect and visualise data in near real-time allowing the creation of 'mood maps' linked to a backend geographic information system. We examine the system's use to date, specifically by the BBC, and the implications of making the toolkit available beyond the e-Science community, essentially allowing anyone to survey the world, nation, city or indeed street via our social survey system.

The authors expand on the concept of crowd sourced data within e-Science with the addition of data mining social networks such as Twitter to collect, map and analyse social related data. Known as 'Tweet-o-Meter' we have developed a system to mine data within a 30 km range of urban areas, focusing on New York, London, Paris, Munich, Tokyo, Moscow, Sydney, Toronto, San Francisco, Barcelona and Oslo. The system mines all geo-located Tweets creating a vast database of social science data and numerous challenges for both visualization and analysis. We also highlight the installation of an 'analogue' Tweet-o-Meter in the British Library as part of the Growing Knowledge Exhibition. The section concludes by arguing that data mining has notable potential to aid our understanding of complex social, spatial and temporal environments. We build on this with a look at our 'Bike-o-Meter' and realtime visualization of the global cycle hire scheme.

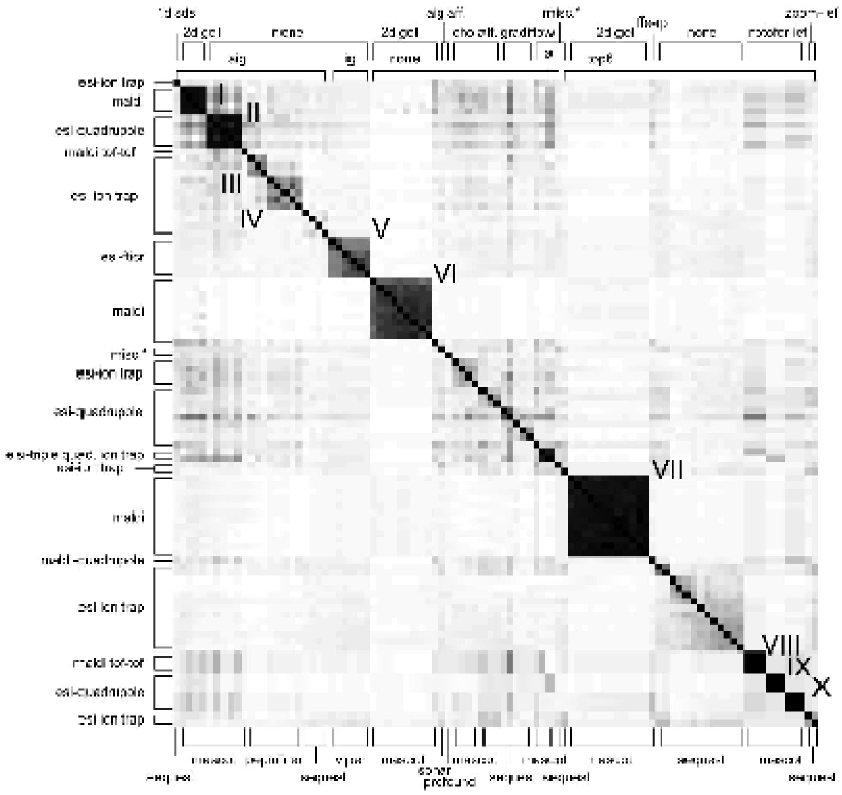
The backend to the SurveyMapper toolkit is known as 'MapTube' which has been developed as part of the Generative e-Social Science project (GeNESIS). 'Generative social science' is widely regarded as one of the grand challenges of the social sciences. The term was popularised by Epstein and Axtell of the Brookings Institution in the book (1996) Growing Artificial Societies: Social Science from the Bottom Up, who define it as simulation that 'allows us to grow social structures 'in-silico' demonstrating that certain sets of micro-specifications are sufficient to generate the macro-phenomena of interest'. It is consistent with the development of the complexity sciences, decentralised and distributed agent-based simulation, and with ideas about social and spatial emergence. In short, the aim is to provide experimental conditions under which key policy initiatives can be tested on large-scale populations simulated at individual level. MapTube provides the visualization component to this simulation, allowing complex datasets to be displayed and overlayed in real-time. We explore the development of MapTube to date and detail MapTubeD, linking to the emerging online datastores to allow the rapid geographic visualization of data.

SurveyMapper takes this one step further. We discuss the integration of the MapTube technologies as well as the decision to 'skin' the technology to create a system suited for use by as wide a range of users as possible. By skinning the technology we have taken the intentional decision to 'hide the science' with the aim of allowing a mass adoption to aid the creation of data. We discuss the reasoning behind this and provide an insight into how this enabled the development of an effective system for e-Research.

We conclude with a look at the use of SurveyMapper beyond the realms of e-Science and discuss how such systems can be made self-sustainable. We detail lessons learnt and provide an insight into how to effectively outreach to the crowd to provide a new source of data whilst ensuring standards and output for the wider science community.

Ruth McNally and Adrian McKenzie (Lancaster University): 'Latent semantic indexing of experiments as text: the making of a literary technology for the virtual witnessing of data production'

This paper is about the visualization in Figure 1 from Klie *et al* 2007. It is a heat map visualization of a protein-based similarity matrix obtained from the use of latent semantic indexing on the results of 95 experiments conducted in 39 laboratories. The experiments were conducted as part of the pilot study for the Human Proteome Organisation's (HUPO's) Plasma Proteome Project (PPP). Modeled on the Human Genome Project, the ultimate objective of the PPP was to identify all the proteins in the human plasma proteome. The results were deposited in public repositories, including the Proteomics Identifications Database (PRIDE). Figure 1 visualises the PPP datasets in PRIDE.



Source: Klie, S. Martens, Vizcaino, Cote, Jones, Apweiler, Hinneburg, Hermjakob (2007) 'Analysing large-scale proteomics projects with latent semantic indexing'. *Journal of Proteome Research*, 7: 182-191.

The main questions asked of this visualization are: What does it represent? And what work is it doing? In this paper, these questions are approached from the perspective of a 'literary technology' (Shapin 1984). This paper tests the applicability of this concept to this visualization; and at the same time, it explores the ways in which the turn to data is and is not a revolutionary transition in experimental science.

Shapin's case study is Robert Boyle's experiments in pneumatics in the mid 17th century, said to represent a 'revolutionary moment in the career of scientific knowledge' (482). Shapin's project was to describe and analyse the workings of the technologies deployed for the production of knowledge through experimental science. For this Shapin looks not to the material technologies and workings of the laboratory, but to the 'literary technology' of scientific communication because 'attention to the writing of experimental reports was of equal importance to doing the experiments themselves' (493). Shapin writes of how the rich circumstantial detail in Boyle's experimental reports was intended to enable readers of the text to create a mental image of the experimental scene that they did not directly witness. He called this 'virtual witnessing'. The literary technology of the experimental reports provided the means for producing an assenting *public* necessary for the production of incontrovertible matters of fact. Once produced, such facts could accumulate and constitute a medium of exchange amongst groups with divergent theoretical commitments (507).

Shapin argues that to a large extent we still inhabit the conventional world of knowledge production that Boyle and his colleagues laboured to make self-evident (482). However, in the early 21st century there is much talk about another revolution in science; the so-called '4th paradigm' of 'data-intensive research' (Hey, Tansley and Tolle 2009) or 'discovery science' (Patterson and Aebersold 2003). For the biosciences, the Human Genome Project is the paradigmatic exemplar of this revolution. In the race to sequence the human genome, data has become an end in itself, marking what some consider a transition in the biosciences (Harvey and McMeekin; Sulston and Ferry). There has been a partial dislocation of the production of data from the writing of a scientific paper (Bowker 2000). In contrast to the mid-1970s laboratory of Latour and Woolgar's *Laboratory Life*, publications are not the only product to leave the laboratory/factory; data is increasingly expected to leave the confines of the laboratory and have a public life of its own.

For conventional experiments, the materials and methods section of a publication satisfy the condition of providing sufficient circumstantial information for their virtual witnessing. When data are the maters of concern, the developing literary technology is the provision of sufficient metadata. However, the provision of metadata had yet to become routine practice in proteomics in 2007.
The intuitive assumption would be that protein discovery experiments on the same tissue should yield highly similar results. However, no single protein was found in every experiment, and only 40 of the 7884 proteins identified were found in at least half of the experiments (Klie et al. 2007). As PPP's leading scientist notes:

> '… the inherent limitations of incomplete sampling of peptides by mass spectrometry and potentially high error rates of peptide identifications and protein assignments with various search algorithms and databases lead to low concordance of protein identifications even with repeat analyses of the same sample. … the same specimen in the same lab typically has no more than 40 to 50 per cent concordance on repeat analysis' (Omenn, *Proteomics*, 2005, 5: 3223-5).

For this reason, although data from proteomics experiments was accumulating steadily, it was rarely reanalysed by others. In other words, although in public repositories, it did not, in practice, have a public life. How to confer a public value on these datasets? How to cultivate assent to their utility, if not to their validity?

The authors and curators of PRIDE could not redo the experiments. However, they could make a difference to their public life through the manner in which they communicated about them. Treating each experiment as a 'document', and each protein identified as a 'term', the authors used latent semantic analysis (a technique from natural language processing) to calculate similarity between experiments. In Figure 1 they plotted the results in a heat map, plotting each against every other. In Figure 1, black signifies identity and the black diagonal line illustrates how each experiment is identical with itself (and only itself).

Rather than ordering the experiments numerically by accession number, the authors re-ordered them according to their metadata. These are arrayed along the top, bottom and left-hand-side axes. When the similarity matrix was organized in this way, clusters appeared which could be interpreted in terms of the experimental methods used. By arraying the circumstantial information in this way so as to frame the analysis, they added value to the data sets by 'carding chaos into a world' (Tarde). Furthermore, they also used their analysis, whose results are captured and visualized in Figure 1, to make a case for others to provide sufficient metadata descriptions when they deposit.

Fabian Neuhaus (University College London) and Timothy Webmoor (University of Oxford): 'Massified research and visualisation. Network effects of data harvesting from Twitter, public API feeds and other social media'

In this paper, we examine some of the implications of born-digital research environments by discussing the emergence of data mining and analysis of social media platforms. With the rise of individual online activity in chat rooms, social networking platforms and now micro-blogging services new repositories for social science research have become available in large quantities. The change in sample sizes, for instances, from 100 participants to 100,000 is a dramatic challenge in numerous ways, technically, politically, but also in terms of ethics and visualisation. Given the changes of scale that accompany such research, both in terms of data mining and communication of results, we term this type of research 'massified research'. These challenges circle around how the scale of, and coordination work involved with, this digitally enabled research enacts different researcher-participant relationships. Consequently, much of the very innovative and creative research resulting from mining such open data sets operates on the boundaries of institutional guidelines for accountability. In this paper we argue that while the private and commercial processing of these new massive datasets is far from unproblematic, the use by academic practitioners poses particular challenges. These challenges are manifold by the augmentation of the capacity to distribute and access the results of such research, particularly in the form of web-based visualisations.

Specifically we are looking at the spatial and temporal implications of raw data and processed data. We consider the case study of using Twitter's public API or application programming interface for research and visualisation. An important spatial consequence of such born-digital research is the embedding of geo-locative technology into many of these platforms. A temporal consequence has to due with the creation of 'digital heritage', or the archiving of online traces that would otherwise be erased. To unpack these implications we consider how a selection of tweets can be collected and turned into data sets amenable to content and spatial analysis. Finally, we step through how visualisation transforms such vast quantities of tabular data into a more comprehensible format through the presentation of several visualisations generated from Twitter's API. These include what one of us has developed as 'Tweetographies' of urban landscapes, as well as examples of recent Twitter activity surrounding the disasters in Japan.

Such analysis raises issues of privacy and ethics in relation to academic approval committees' standards of informed consent and risk reduction to research participants. Such massified research and its outputs operate in a grey area of undefined conduct with respect to these concerns. For instance, what are the shifting boundaries of public and private space when using Twitter and other platforms like it? Are Twitter and other social media platforms' disclaimers as to privacy sufficient justification for academic and commercial use? Are the standards of social science research protocols applicable to research on and for 'the masses'?

To conclude, we discuss propose some potential best practices or protocols to extend current procedures and guidelines for such massified research.

Paper session: Identities of visualisation

16:00-17:00, Andrew Cormack Seminar Room

Chair: Marina Jirotka (University of Oxford)

Robert Bhatt (University of Umea): 'Moving beyond beauty in medical imaging: an ethnographic study of the role of three-dimensional visualisations as boundary objects in medical science'

In my paper I present initial findings from my research project about the role of three-dimensional visualisations in medical science. Technically these objects can be described as digital displays of functional and/or anatomical information derived from MRI- (Magnet Resonance Imaging) and CT- (Computed Tomography) examinations.

My overall project focuses on the “boundary work” (Star/Griesemer 1989) of scientists in this field. Within this scope I have encountered practises and narratives relatable to Daston and Galison’s description of the move from representation towards presentation in scientific “objectivity” (2007). Following this understanding of “doing science” my paper also analytically addresses the “personas” fostered in the context of the research center where I am conducting fieldwork. This site is geographically located in the southern parts of Sweden. Institutionally this milieu is situated in-between academic research, clinical practise and commercial development, which is in turn reflected in a widely diversified and organisationally distributed work force.

In popular medical discourse and national technological policy in Sweden visualisation technologies are commonly held as tools that will ”revolutionize tomorrows healthcare”. In regards to clinical interests such statements can be argued as neither clear, nor dismissible. The center and its affiliates have become poster examples of “Triple Helix” structures of science and innovation. Simultaneously scientists reflect upon the anxieties about wide spread clinical application. This contradiction has become clearer through my participant observations of clinical examinations, “shop talk” (Lynch 1985) and on-going deep interviews with scientists.

Thus I have been able to study the scientific modes of conduct, or “situated knowledges” (Haraway 1988), evolving under the diverse conditions of this setting. My empirical entry point into the discussion of objectivity is the issue of “validation” as it is articulated in regards to the different expectations and local resources at hand. In my paper I discuss these modes in light of two projects launched within the center. These projects make use of popular media and media technologies in ways that reportedly annoy other members of the wider scientific community. Yet “scientifically”, in the terms of the center’s own members, the same strategies have proven crucial in making institutional advances, thus highlighting the very much cultural contingencies at play in this story.

It is through an analysis of these local strategies of validation, and the associated narratives about scientific accountability that I seek to expand the knowledge about objectivity briefly, but thoughtfully, touched upon by Daston and Galison.

Navigating in the field of visualisation one, perhaps inevitably, also finds oneself in the middle of discursive contentions about the value of artistry and aesthetics to science. Quoting my informants, a change of “people’s”, or more accurately “physicians”, perceptions of their work as “simply pretty pictures” to valuable diagnostic tools surface as an essential task in medical imaging. Such statements may hint at boundary work with an interest in making distinctions between scientific visualisation and art. But more interestingly, in reference to Daston and Galisons “personas”, the described controversy perhaps bear witness to clashes between and hierarchies of personas in the medical arena. Such battles also influence the nature of doing science among these scientists.

Given the mentioned, sometimes denoting value placed upon “all too” vivid and colourful visuals in medicine I have observed some counteractive moves within the projects I am studying. Here collaborations and disciplinary expansions towards new computationally driven fields such as “Visual Analytics” - providing the leverage of “digital objectivity” (Beaulieu 2001) paired with Daston and Galisons “trained judgement”- lend potential arguments for communicating clinical usability. In my future research I will look closer at such attempts of medical epistemology and the cultural implications of these social connections for the boundary work of imaging scientists.

Luis Felipe R. Murillo (UCLA): 'Partial perspectives in Astronomy: gender, ethnicity, nationality and meshworks in building digital images of the universe'

Digital images are not the transparent product of a prescient, panopticon devices. Imploded in those images are webs of cultural and epistemological relationships in transnational science circuits. Our current research is focused on the trajectory of scientists working with large-scale databases in astronomy. We trace connections and map relationships among researchers, as they strategically build their careers, digital infrastructures, and visualizations. We are specifically interested in exploring astronomers' situated "ways of knowing" (Haraway 1991, Traweek 1988) as manifested in emerging data practices. We look at how gender, ethnicity, nationality and institutional affiliation are intersected in the process of scientific formation in astronomy, as well as in the process of enrolling technical partners for the construction of instruments, design,implementation and data visualization. Work that once figured as merely technical support, such as assembling data catalogs or doing graphic design, generating pleasing images for public and professional usage has been repositioned in the field.

During the first year of our oral history interviews and ethnographic encounters we have investigated how networks are composed to support a career in astronomy for under-represented groups. In elaborating on the concept of "meshwork", we describe the bundle of relationships (network of networks) that is the condition of possibility for women, minorities and foreign-born researchers to advance their careers by establishing ties of various sorts. Our initial hypothesis was that our target group tends to rely on closely-knit meshworks in order to build a career in science, while for other individuals, meshworks tend to be loosely-knit.

In this paper we address specifically how big data-driven science is promoting new political arrangements in respect to knowledge production in astronomy. For social sciences, this transition represents the challenge of how to map and visualize complex meshworks of astronomers based on a corpus of qualitative data. In order to tackle the problem, we describe personal trajectories in astronomy using network visualization tools. Due to its complexity, meshworks tend to be hard to visualize, given its form as an intricate bundle of heterogeneous ties. Also, we discuss three types of visualization: astronomers on astronomy, astronomers on astronomers, and ours on astronomers. Just as astronomers build images from diverse kinds of observational data from multiple sources, we extract heterogeneous relational data from narratives and from our participant observation fieldwork in research institutes, observatories and professional conferences.

As a concluding argument, we discuss how meshworks allow the integration of women and minorities in big data-driven science projects, using meshwork visualization, as well as describing native data visualization techniques, which are becoming increasingly a focal point of research activity for both established and aspiring astronomers.

Installations and demo presentations: Hands on visualising

16:00-17:00, Seminar Room A

Chair: Federica Frabetti (Oxford Brookes University)

Luke Church and Alan Blackwell (Crucible Network for Research in Interdisciplinary Design and University of Cambridge): 'Computation, visualisation and critical reflection'

We will be demonstrating several prototypes of visual systems that are intended to allow heterogeneous interpretations of computational mechanisms. Our prototype systems might be regarded broadly as members of the class of visual programming languages, although when considered from this perspective, would also be found idiosyncratic in many ways. We have constructed these interactive visual systems specifically as a challenge to the predominant technical characterisation of programming languages. This challenge is driven by scenarios of use suggested to us by artists and dancers, as well as by scientists who find current programming technologies inadequate for the volumes of data, speed of change, and flexibility of thinking required in dealing with contemporary data analysis challenges.

Gordana Novakovic and the Fugue team (University College London): 'Fugue'

Six years ago, when I began to work on the artwork that became Fugue, I was inspired by contemporary theories of the digital revolution, the global city and globalisation, and the way that fear spreads (and is spread) through the mass media, mutating as it goes, in a manner very similar to a pandemic. I soon became interested in the immune system, and began a collaboration with Dr. Bentley, a computer scientist who had built some of the first computational models of the immune system. We obtained funding which was directed towards the development of a piece for the visualisation of scientific findings, and in 2005 we produced the first version of Fugue. It turned out to be the first ever audio-visualisation of the dynamics of biological processes, and one of the first audio-visualisations in general. We described it in a position paper for a scientific conference in 2005, and discovered that the scientific community did not seem to assign a high value to this kind of work.

We continued to develop the piece primarily as an artwork in the area of art|science. Around 30 more presentations and exhibitions followed, in different contexts, formats and scales, including a large-scale interactive installation in 2007. The reception of the piece as an artwork was very successful, even at scientific conferences, and we gave little further thought to its potential value as a scientific visualisation. However, in 2009, Fugue was invited to be exhibited at “INFECTIOUS! Stay away!”, a major 3-month public engagement exhibition in Dublin Science Gallery. INFECTIOUS! was a spectacular theatrical mix of scientific demonstrations and art|science projects, and was extremely successful. One surprising outcome was that Fugue was featured in Nature Immunology, one of the most prestigious scientific journals; it seemed that its importance to scientists was as a bridge to the public understanding of their work, and that this was something to which they did assign a high value.

In conclusion, although the core computational processes behind the curtain have remained unchanged throughout, the work has been perceived and read in many different ways by different audiences. Whether it is seen as art, science or something else seems to depend on the viewers’ background, the context, and perhaps even the mood of the times. The Fugue story still continues. At present, we are working on a version of Fugue as a theatre performance, and also as the basis for the scientific examination of the neurological basis for changes in perception when a person engages in interaction with a synthetic environment.

Brief description:

At the heart of the piece is a complex piece of scientific software. It is an artificial immune system algorithm – a computational model that is accurately mimicking the changes and cascading responses of the human immune system in the real-time.
However, Fugue does not mimic what can be seen under the microscope. Instead, the artists in the team have taken the data the data received from the artificial immune system and transformed them into symbols to express the dynamics and the rhythm of the biological processes. It is entitled Fugue, because the artists found the inspiration for the concept in the resemblance between the nature of the complexity of the immune system to the complexity of the musical form of fugue. We usually invite our audiences to watch, listen and attune themselves to the rhythms that are mirroring what might be happening right now, inside their own bodies.

Visual Concept

The visual aspects of Fugue took shape many years ago, in a long series of my abstract paintings with a strong cellular theme, exploring the similarities between micro and macro-cosmos. In order to underpin the focus on processes, the conventional 'real' images of the lymphatic system have been reduced to symbols. I produced clay models to form the basis for Fugue's visual language; the roughness of the clay was deliberately retained when the models were digitised. The other components, including the lymphatic vessel, have also been left in a basic, rather sketch-like form, and the colour has been reduced to a monochromatic grey scale. The models were scanned in 3D by the computer scientist Anthony Ruto, and used to prepare wireframe models that could then be rendered appropriately.

Sound Concept

Fugue's sound software is based around a series of customised audio players ("Fugue Players") that respond in real time to changes within the artificial immune system. An array of variables is passed to the sound system at regular intervals, representing a 'snapshot' of what is happening inside the artificial immune system at that particular time. The data array, or 'data state' of the artificial immune system is compared to its previous stored counterpart to detect which values have changed in the meantime. Any new values are passed to handler routines which parse and analyse the artificial immune system data state and initiate a suitable change in the sounding process. An example of a data parsing procedure is to register changes in the direction of growth of particular immune system cells over time.

Currently only vocal samples are used in the sound design; they are stored as 16 bit, 44.1kHz mono samples. The customised audio player concept challenges the phonographic paradigm, of which audio CDs or internet streaming files are examples. Here, instead of the mechanical playback of fixed sound data from a disk or file, the audio player combines and renders source wavetable information in real time, providing a listener with the possibility of a unique and customisable listening experience.

Details of the artistic and scientific aspects of the project, and the documentation of around 30 presentations and exhibitions in different contexts (both scientific and artistic) can be found at the project's website: www.fugueart.com

Authors of the Fugue project: Gordana Novakovic (visuals), Rainer Linz (music and sound software), Dr Peter Bentley (computational model of the immune system) and Dr Anthony Ruto (3D modelling), plus a team of medical and technical experts.

Alison Munro (Australian National University): 'Thinking about science and drawing'

My installation is called "Thinking about Drawing and Science" and it is made from a single length of lurex thread wound around dressmakers pins which have been pressed into a wall. The pins form the corners of simplified crystal forms. The thread is wound around the pins to create isometric drawings - simple, regularised linear versions of phenomena that exist in the natural world as irregular, complex specimens.

The crystal shapes in the installation are linked together; the thread that forms one continues on to form the next and the next and so on. The geometric implication of thread as a form of line is that it continues indefinitely. And so the crystal forms are repeated through a potentially infinite series of inscriptions whereby each iteration is composed of the same thread, pins and shape (or 'data set'), but is slightly changed by the process of its inscription. The materiality of the thread winding around pins creates both an illusory (perspectival) space as well as a real space where the layers of thread create an actual depth in each crystal outline. This allows the works to oscillate between two and three dimensions, isometric and perspectival space, alluding to the ambiguous spatiality of understanding the natural world via scientific representations.

My PhD research examines processes of mathematical inscription and translation in relation to scientific representations of the natural world and how these might relate to the specific spatial qualities of textile-based media. This research builds on my interests examining the codes and patterns used to represent and 'construct' our contemporary understanding of, and interactions with the natural world. My art practice spans textiles, print and drawing-based media and I have exhibited throughout Australia and internationally. I am currently undertaking a practice-led PhD in the Textiles Studio of the Australian National University School of Art.

Keynote 2

17:30-18:30, Lecture Theatre 4

Peter Galison: ‘Digital objectivity’

Scientific vision is not static and never has been—instead, a constant upending of what counts as right depiction alongside a never-ending revision of the ethical position of the observer. Focusing on compendia of images, the defining guide of working ontologies of the sciences, one can see images aimed at idealization joined to the 18th-century observer-sage; a period in the 19th century of images aimed toward mechanical objectivity produced by the self-abnegating worker-observer; and a 20th century interpreted image powered by the apprenticed expert. We now stand in the opening era of new forms of digital images, and a radically new position for the observer. New image-forms have proliferated, including simulations, nano-manipulations, re-scalings, and false-color renditions—alongside virtual, enhanced, and manipulable hybrid realities. Compendia of such images—these *hyper-atlases*—press us to ask the concomitant question: what is becoming of the ethico-scientific status of the human observer?

Saturday 26 March 2011

Keynote 3

10:00-11:00, Lecture Theatre 4

Michael Lynch (Cornell University): 'Image and imagination: an exploration of online nano-image galleries'

This presentation is based on an ongoing project with Kathryn de Ridder-Vignone (also of Cornell University) that explores online image galleries. These galleries present collections of digital images associated with nanoscience/nanotechnology (nano-images for short). Image galleries present work from a growing number of scientific fields, but in no other research area are they as closely bound to the promotion and public interface of the field as they are in nano. Unlike many scientific images that are of interest to art historians and historians of science, images in nano galleries are selected, and often produced, explicitly *as* art. They are seldom valued as ‘high’ art, and appreciating them as art requires at least a minimal understanding of the scale of the source objects and fields. The images collected in these galleries are quite diverse, and as an initial step in coming to terms with them, we present a rough typology of their formal and functional characteristics. These include ‘empirical renderings’, ‘displays of technical virtuosity’, ‘self-assembled objects and landscapes’, ‘idealized images/models’, and ‘fantastic voyages’. Particular images differently display technique through form, draw out structural details, and merge imaginary features with material forms. Interestingly, compared with other types of nano-image, the most fantastic images place the least amount of burden on the viewer’s imagination.

Paper session: Envisioning biology

11:30-13:00, Lecture Theatre 4

Chair: Tanja Schneider (University of Oxford)

Johannes Bruder (University of Basel): 'Computing the brain. Images, models and visualisations in contemporary functional neuroimaging'

My paper reviews up-to-date imaging and visualisation practices in computational and systems neuroscience from a socio-historical perspective with the goal of integrating epistemology and its specific enactments.

Neuroscience has undergone various epistemological shifts and reorientations. Especially technical developments in the post-war era radically challenged the traditional antagonism of vitalistic and mechanistic conceptions of life by paradigmatically initiating the informatisation of biology and the biologisation of the mind. Contemporary neuroscience is a descendent of this process and has integrated various measurements techniques into its framework allowing the equation of physiological processes with cognition and learning. The discovery of a possibility to create functional images with, for example, MRI is maybe the most important to date since it brought anatomy and biology together in a transdisciplinary endeavour to understand what's going on in the brain by visualizing brain activity. However, images of brains have existed before and the mind-in-the-brain (Beaulieu 2000) is not equiprimordial with functional imaging devices. Drawing on two visualisations of the mind-in-the-brain (1947/2010), I will try to show the kinship of cybernetics' images of the mind and visualisations of brain function in cutting-edge neuroscience. The physiognomy of the brain and its function is at the same time framed by distinct culturally shaped epistemologies and enacted in local constellations. Epistemological frames are actualised in processes of (visual) knowledge production which is why I will also cite interviews with researchers in neuroimaging laboratories to strengthen my argument.

Merete Lie (NTNU): 'Displaying human cells: scale and autonomisation'

Visualizations of the body display an enormous variety in terms of choice of focus, technologies applied and presentation of the results; thus they contribute to very different imaginations of the inside of the body. This paper will present images of human cells made possible by new medical photo techniques. In presentations of such images, the scale of magnification is often emphasized. Whether such scales are in fact imaginable is itself a debateable question. It is in order to question imaginations of scale related to images of the inside of the body that this paper focuses on images of human cells. Apart from human egg cells (possibly), these entities are not visible to the eye. New medical visualization technologies enable the production of digital photos of human cells that are magnified to the size of a body organ. In the media, and particularly on the internet, there is a variety of images of skin cells, brain cells, cancer cells, etc. in bright colours. The point is that material previously presented on the level of theories of the composition of organic matter, such as cells, now appear as 'physical' entities, though only as depictions because they are too tiny to be presented in flesh. When scientific cellular images move out of laboratories and become available to the public they can be refashioned to reveal matters more clearly for pedagogical purposes. Organic matter that might be confusing to the audience may be removed and colours may be added to distinguish particular aspects. However, the images used for scientific purposes have also gained aesthetic as well as dramatic appeal, first of foremost because of the enormous magnification – revealing previously unknown structures – and also because of the use of strong colours.

The paper will present cell images from the information webpages of the Norwegian Research Council. The images are used as illustrations of information relating to new medical research. The analysis will focus on the process of *entification* whereby human cells appear as distinct entities separable from the context of the human body. The concept of *entification* refers to a more general social trend where the inchoate increasingly gains 'thinghood' by going through a process resulting in externalization and autonomization[i]. The paper discusses how medical imaging technologies provide new material for imaginations of the body : what are cells depicted 'as' in the sense of characteristics, metaphors and comparisons, and what does it mean that human cells appear as distinct entities and in large scale – similar to organs such as the heart and the lungs?

Janina Wellmann (Tel Aviv University): 'From ‘seeing in-between’ to the ‘in toto’ representation of the embryo. Representations of biological development ca. 1810 and ca. 2010'

For the last two hundred years, the developmental series has served as the main means of visual representation in embryology. The typical developmental series consists of a sequence of images each depicting a different stage in the genesis of the embryo and which, taken together, convey the complete process of embryonic development from a single cell to the complete organism.

Over the last two decades, novel techniques of imaging have been introduced, whose aim it is to represent the totality of the developmental process from the perspective of the expression of genes in single cells. Ultimately, the goal of these attempts is to provide a representation of the process by which, through the gradual division, differentiation and migration of cells, a complete tissue, and also the complete embryo is formed. One of the most remarkable steps toward the accomplishment of this goal is a novel technique called “in toto imaging”. The technique, which has hitherto been applied notably to the zebrafish, is based on combining several other technologies such as laser-scanning-microscopy (LSM), fluorescent tagging and the application of three-dimensional (3-D) imaging technology. With these techniques, three-dimensional (3-D) images can be generated by capturing a stack of two-dimensional (2-D) images, reconstructing them and dynamizing them on the temporal axis. Ideally, the technique should allow the construction of a ‘digital embryo’, in which every single step in the developmental process at single-cell resolution will be represented.

My paper will discuss the impact of these new technologies on the understanding of embryological development in particular and on the biological concept of development in general. The paper will be organized around two historical poles. The first part of the paper will discuss the emergence of embryology as a science in the period around 1800. I will argue that the pictorial convention of the developmental series was a new technology of representation, which was invented and employed for the first time by a group of German biologists, notably Christian Heinrich Pander and Karl Ernst von Baer. Moreover, I will argue that the visualization of development by means of developmental series was constitutive for the emergence of a new concept of embryological development, which, in turn, became central for the epistemology of embryology throughout the 19th and 20th centuries. In particular, I will discuss what I call the technology of the ‘in between’ by which a relatively small series of discrete observations is used for the construction of the representation of a seemingly complete, continuous development. In the second part of the paper, I will describe the technologies underlying the novel ‘in toto’’ representation of embryogenesis and in particular the case of the zebrafish. I will compare the epistemology of this new technology to the older epistemology of the ‘in between’ characterizing the iconography of the developmental series. Finally, I will discuss the extent to which the new technology is challenging the traditional understanding of biological development, the embryo and the visualization of living processes.

Paper session: Embodiment and visualisation

11:30-13:00, Lecture Theatre 5

Chair: Liv Hausken (University of Oslo)

Matt Edgeworth (Durham University): 'Computer applications and their influence on perceptual encounters with material evidence during archeological excavation'

This paper examines the extent to which the practices of archaeological fieldwork - in particular the perceptual encounters that archaeologists have with material evidence out on site - have been influenced by computer technology over the last forty years.

It is well known that digital technology has transformed how material remains are visualised and represented in many aspects of archaeological work – in post-excavation processing and analysis, database management, mapwork, archaeological publishing, and so on. Most archaeologists today, when not actually working out on site, spend a large proportion of their time at the computer. The material culture of archaeological offices has radically changed over the last four decades or so. Gone are the inked-in plans, written matrices, rough-outs of publication drawings, and so on. Gone too are the letraset kits, coloured pencils, sets of technical pens, tracing paper pads, drawing boards, rulers, and associated material accoutrements which once covered the desks of archaeologists. All these have now been largely replaced by computer software programmes. Tasks which formerly took place at a table, writing desk or drawing board have been transferred onto keyboard and monitor, with corresponding shifts in the skills, postures and talk of the archaeological workplace.

But the extent to which computer technology has impacted on fieldwork practices of excavation is not nearly as great. While some areas of work such as surveying have been greatly transformed, the core practice of the archaeological profession – the digging and recording of material remains out on site - has been relatively resistant and impermeable to computer-oriented ways of seeing. In excavation, the traditional material culture - a fairly basic technology of trowels, spades, mattocks, hand-shovels, buckets, string, nails, and wheelbarrows - has stayed more or less the same. Site plans and sections are still for the most part measured and drawn by hand, and recording sheets filled in with handwritten notes and sketches. Digging remains a manual set of embodied craft practices. Not counting the presence of digital cameras which are widely used, excavation is actually one of the very few scientific workplaces where digital technology (and modes of visualisation entailed in its use) may be largely absent.

Given that most data end up in digital format, this relatively non-digital material environment and the predominance of non-computerised modes of perception out on site seems strange, in need of some explanation. It is clearly not the archaeologists themselves who are resistant to new ways of seeing, since many move from spadework out on site to screenwork back in the office on a daily basis. The strong tactile dimension to archaeological fieldwork may have something to do with it. In excavation, touch is routinely used alongside vision to make sense of emerging material evidence, and it is precisely this that gets left out of computer representations. Could it be, then, that it is the very textural and tactile characteristics of material evidence encountered (its roughness, wetness, coldness, plasticity, malleability, softness, hardness, and so on) that presents resistance to the computerised forms of visualisation that have become ubiquitous in almost all other areas of archaeological work? Do archaeologists who work both out in the field and in the computerised office step in and out of different modes of perception? Taking an ethnographic stance on the practices of archaeological fieldwork, I set out to explore the friction between traditional craft practices (that entail active use of the sense of touch alongside vision) with computer-oriented modes of perception (that prioritise vision over all other senses).

Trine Haagensen (University of Oslo): 'Has the human left the building yet? Questioning the transcripted truths of prosthetic visualisation technology'

In this paper I will discuss visual representation of scientific astronomical images of invisible phenomena, and reflect on how these representations create the impression of technological objectivity and non-human intervention. Furthermore, I will argue that the development of new prosthetic visualization technology in satellites seemingly displace utterly the acknowledgement of human partaking in construction of the astronomical images, leaving the impression that the images are neutral imprints independent of human hands – from the view of nowhere. A similar claim has been made by Martin Kemp, who alleges that "the more technological the image looks, the more it exudes the authority that comes with the highest levels of electronic complexity (Kemp, 2006:321).

Starting from the "The Planck multi-colour one year (or all-sky) survey image", as represented on the European Space Agency's web pages, I will argue from aesthetical and media sensitive perspectives, that scientific astronomical images are displayed as mechanical transcript truths, similar to 19th century discourses of photography (Daston and Galison: 1992, Hoel, 2005:290-291, Kriebel, 2007:8). Following the writings of Don Ihde (1998, 2010), I will argue that these images on the contrary are very much embodied, and that the visualization technologies that gives access to invisible astronomical phenomena (translational technology) raises important epistemological questions.

Planck multi-colour one year survey image – a view from nowhere?

Satellite technology enables astronomers to reach formerly unavailable areas and phenomenon in space. These satellites floats around in the universe, as neutral and objective observation posts– in the same manner that Susan Sontag described photography "as both a pseudo-presence and a token of absence" (Sontag, 1990[1973]:16). Similarly, new visualization technology gives access to phenomenon outside the reach of human perception.

The Planck spacecraft is one of the satellites that combines the "to far away to be seen" and the inaccessibility to human senses- aspects of visualization. The spacecraft was launched in May 2009. ESAs Planck mission is to detect and collect Cosmic Microwave Background (CMB). The images constructed from the data derived from the Planck instruments, are constructed for the function of exposing registered Cosmic Microwave Background (CMB). CMB is explained by ESA to be the first light that existed freely in the universe, and does not stem from one particular light source. The observations of this first light is therefore claimed by ESA to be understood as a time travel – like seeing the universe as it was only 300.000 million years after the Big Bang (ESA – Travelling back in time: 2004).

Planck consists of a telescope and two detectors: a low frequency instrument (LFI) and a high frequency instrument (HFI). The first instrument (LFI) work as a radio: the telescope functions as an antenna that collects signals, an array of 22 tuned radio receivers amplifies the signals, whom thereby are converted to a voltage. These voltages are then stored in a computer for later analysis. The high frequency instrument (HFI) is an array of 52 bolometric detectors, working in six frequency channels, and converting radiation to temperature. The data are compressed within the service module of the spacecraft, and transferred to earth for further processing (ESA – Planck all-sky image, 2010).

In this paper I will depart from "The Planck multi-colour one year (or all-sky) survey image" (see appendix). This specific image is constructed by synthesizing data from the full frequency range of the Planck instruments (30-857 GHz) collected through a whole year. The image shows an all-sky map, with superimposed previous Planck images, a selection of extragalactic sources, and a map of molecular clouds (ESA – Planck all-sky image, 2010). The image is credited ESA, HFI and LFI consortia (Ibid).

Whereas astronomical photography foremost can be understood as magnificational mediations, the Planck images can be understood as translational mediations (Ihde, 2010:63). The Planck multi-colour one year (or all-sky) survey image is constructed from the data from the LFI and the HFI, but *are not* the data in themselves. The image-constructing process of invisible phenomenon such as the CMB (or time travel as ESA coins it) is fundamentally dependent on what the scientist are looking for, how they look for it, and the decisions on how the images eventually shall look (Kemp, 2006: 315, 321, Ihde, 2003: 16).

The complex and laborious process of constructing images from Planck`s data makes the scientific objects available to the scientists. This process raises two significant epistemological questions. The first concerns the relation between the scientific subject (researcher) and its objects (image). The second concerns the images statuses.

Firstly the scientists are partaking in the constructions of their own scientific objects. Consequently the scientists are embodied in their own scientific objects, Or as Don Ihde claims:"our embodiment is being referenced in this science practice!" (Ihde, 2003:17).

Secondly the scientific statuses of the images are questionable in sense of the process of imaging – from theories of phenomenon to development of instruments, to acquired data, to analyzing data and constructing image, and finally the use and distribution of the image. This opens up for critical reflections on what and how the images represent, whether they are scientific objects, hypotheses or conclusions. Or, if the scientific images possibly occupy all these statuses at the same time.

In this paper I will explore the discourse of authority and credibility that seems to be connected to advanced prosthetic visualization technology and the questions of embodiment and possible alternating scientific statuses of "the Planck multi-colour one year survey image".

URLs

ESA – Travelling back in time (2004):
URL: http://www.esa.int/SPECIALS/Planck/SEMU3QS1VED_0.html
(accessed 01 Dec. 2010).

ESA – All sky image(2010): URL: http://sci.esa.int/science-e/www/object/index.cfm?fobjectid=47333
(accessed 01 Dec. 2010).

Adam Rosenfeld (SUNY): 'From representation to performance: convergence of the dry-lab and wet-lab and manipulation of fictional models'

While it is fairly well established that many models and other forms of representation in science strategically employ distortions in order to effectively portray their targets, the predominantly representationalist focus in accounts of this style of representation have underemphasized the performative aspects of modelling practices. Consequently, questions regarding how such models act as tools for inquiry and function in a "context of discovery" have gone overlooked and underappreciated. This paper will seek to draw attention to these questions and offer preliminary suggestions for how we might go about answering them.

Turning to visualization in models helps us to overcome a bias favoring formal/mathematical features of models and their target phenomena, in favor of attending to their phenomenal features. In particular, many computational models have shown promise for studying complex systems by showing that complex systems resembling actual systems are derivable from relatively small sets of relatively simple rules and these models frequently require a visual interface to make sense of large data arrays. But discussions of such models still retain an erroneous assumption that we always know which features of the target phenomena we are aiming to highlight when we model them, and that the important productive distortions are ones which are intentionally built in. More often than not, the ways in which a model deviates from its target are either defended as being irrelevant and/or inconsequential to the phenomenon being investigated, or else attacked as significant and problematic. I argue that such deviations and distortions can be significant and productive, and moreover that they are particularly productive of novel discoveries when they are unintentional.

I begin by outlining a position that asserts exemplification of salient features of target phenomena as the goal of many forms of scientific modelling. Representation by exemplification has an asymmetric directionality due to human intentionality that runs contrary to both objectivist, correspondence theories of representation as well as symmetric so-called semiotic sociological theories of scientific practice (e.g. actornetwork theory). Furthermore, the intentionality of both the designers as well as the users/interpreters of models must be accounted for in order to provide an adequate account of exemplificatory representations in scientific modelling. Additionally, drawing on insights from R. Giere, M. Morgan, and M. Morrisson, I argue that scientific models are not merely instruments of representation, but also semi-autonomous objects of study that are manipulated in a context of exploration and discovery. Thus, what is exemplified and made epistemically accessible by a model is not necessarily known in advance and/or designed into a model intentionally. This requires a somewhat playful and spontaneous dimension of model construction that allows for a model to give back more than is put in to it, to be what R. Crease calls a "performance" rather than a mere "demonstration."

I examine the above account via a case study taken from I. Peschard concerning efforts to explain linear discontinuities in the wake dynamics of fluid mechanical systems. A computer simulation with an ambiguous visual representation plays a significant role precipitating a major shift in the scientific debate by revealing a novel feature of the system as salient to studying the phenomenon. What is shown is that models employed in the sense described above must necessarily underdetermine how they are interpreted, that they must be multi-stable objects, if they are to support the sorts of discoveries we expect of scientific inquiry.

Poster session and demo

11:30-13:00, Seminar Room A

Amanda Windle (London College of Communication; University for the Creative Arts): 'Inscribing complexity: diagrammatic interventions'

> 'Rudiments,' as the little preamble you mentioned explained, are studies that are left undeveloped. The material itself is not refined; it is in the process of refining itself. (Lyotard and Thébaud, 1979:15)

Rudiments are iterative processes, a form of speculative research design used to probe the ways software agents, interact. From the book 'Just Gaming' (1979), by Jean-François Lyotard and Jean-Loup Thébaud, I borrow and extend the principle of Rudiments. Rudiments were used as a part of a doctoral research project to intervene with conventional experimental methods. Experiments are uncovered and understood by the rudimentary process. This paper will consider the interrelation between a rudimentary method by practice and the interventions that can be made into existing methods of experimentation.

In the 1950s Artificial Intelligence expert systems emerged. Sixty years on expert systems operate online within social networking interfaces. These software agents are applied to all forms of automated service. I will investigate mapping processes undergone in a study of a particular kind of software agent called chatbots. As a part of the PhD by practice maps were designed to understand the interrelation of speculative design processes such as — affinity diagrams, bricolage, co-word occurrence tests and Leximappes (Cambrosio et al., 2004), to existing mapping techniques in AI but also used within the social sciences (Latour and Teil, 1995).

An AI Laboratory in Italy subsequently commissioned several of the maps that were designed as a part of the research process as examples of AI complexity. The diagrams appeared to be (and enacted) the visualisation techniques of AI network diagrams. On the one hand this mapping was a way of stabilising the complexity in the research. However, the mappings were sometimes making certain themes superficially simple, whilst at other times the visualisations were making research overly complex. Often it was a bit of both. I will show how computational techniques begin to blur the distinction between representation and intervention.

Dolores and David Steinman (University of Toronto): 'Biomedical simulations and their challenges to the medical visual culture'

Visualisation has always been an integral part of understanding the human body, and medical images have always played an educational role while also providing a cultural corollary and mnemonic aid. The need to see beyond the range of the bare human eye has always been a major driving force in the development of medical imaging technology. Although advances in digital imaging and computer image processing have sharpened the resolution and quality of anatomical imaging, it remains a challenge to measure and visualise the biophysical forces that drive normal and pathological processes. One of these, the mechanical force exerted by flowing blood, has been the focus of our laboratory's investigations for many years. To effectively "see" these forces, we have used "image-based modelling": anatomical imaging coupled to engineering computer simulations. We find our experiences in translating binary data into clinically compatible representations of otherwise-unseeable anatomo-physiological processes relevant to the topic of the conference and will reveal and discuss the various issues and concerns as we have encountered and addressed them directly.

In our practice we make recourse to computational fluid dynamics (CFD) engineering software to simulate the underlying blood flow, using artery geometries derived from traditionally collected medical images, such as Magnetic Resonance Imaging (MRI). It is a multi-step process through which, from the reality of the human anatomy and the physiology of blood flow, a mathematical model is first created and then converted (owing to complex computing) into a visual representation of the phenomenon observed, the last step being the refining of the image and making it understandable to the user. The end result, namely the medical images and 4D simulations (3D flow patterns throughout the cardiac cycle), serve two purposes: that of a model for a phenomenon or disease, or that of a model for an experiment, thus gliding from representation to intervention on a gradual scale. These medical-computational mash-ups have the scope of augmenting the clinician's ability to examine and study, and they seamlessly merge the real and the anticipated in an effort to bring objectivity into the process by minimizing the human factor involved in data collection and quantification.

One of the central challenges of this new form of computational seeing is that, while capable of being rendered with remarkable apparent realism and precision, it belies the many underlying intermediate computed interventions. Thus, computational seeing may lead to an artificially precise perception where uncertainty is hidden in the representation (unlike anatomical imaging where uncertainty is effectively encoded as well-understood image artefacts). This is to say that digital images, in our case, involve both an intervention at the representational level and well as the conceptual one. On the other hand, this potential for accuracy and clarity of detail is an advantage of such computer-generated simulations, as well as their ability to represent a tissue or organ in its original environment with the option to mimic its anatomical and physiological interactions.

An unexpected development was our realization that through our advanced visualisation techniques that mimicked x-ray angiography (a crude but clinical gold standard), we were able to represent the blood flow in an unaltered condition, which was an improvement over the "real" angiogram (involving the replacement of blood with contrast agent, thus disturbing the actual flow and leading to a distorted version of the local reality of the patient's flow). This aspect of computational seeing definitely challenged our notions of real and connection between the virtual and the actuality of the body. Confident of the accuracy of our results we were confronted with a new objectivity that would no longer belong to the direct recording of a mechanical procedure but would rely on the prediction and representation by the computer simulation.

Another revelation brought by this project was the clinician's affinity for a traditional angiogram look-alike computer-generated image, emphasizing the cultural and aesthetic canon and trends that influence the perception of the users. We continuously develop and amend our "virtual images" by rapidly adapting and fine-tuning the appropriate technological tools but also by blending current medical information with established visual clinical conventions. In an uncharted territory the new visual idiom needs to be clear and accurate without being to simple, but it also needs to address the clinical sensibilities while incorporating novel modes of representation.

The increasingly blurred lines between medical image, computational simulation, and computerized representation bring to light issues of reliability and reproducibility, which are beginning to be acknowledged and addressed by healthcare regulatory agencies seeking to introduce these integrated technologies into the clinic. Correspondingly, the images generated in our laboratory and others are seeping into the popular culture in addition to becoming household images for patients and their families, by means of medical files. Medical imagery has found numerous non-scientific uses, and as everything from simple electrocardiogram (ECG) lines to more complex computer tomography (CT) or MRI images have become iconic, it becomes challenging to prevent either their potential misinterpretation or manipulation of the public through this new scientific visual language.

As medical imagers and modellers we become the apparatus that renders the hidden body visible, and it is ours the subjectivity of choice between transparency and concealment, hence the fine balance to be kept between the commitment to truth and the actuality of the body versus its realities and the seduction of visualisation.

Jennifer Tomomitsu (Lancaster University): ‘‘Seeing’ as feeling: embodied material practices of 3D image reconstruction’

Computers have become increasingly important with respect to scientific modelling practices and now play a central role in the production and analysis of data. Many areas of research utilize digital image media to represent and display various chemical, biological or physical structures particularly in areas like medicine or biology which heavily depend on images as knowledge tools. Computers generate the ability to manipulate data onscreen with an almost unlimited means of rotating, shading, and dissecting objects into different planes.

This paper presents the practices of digital image reconstruction, a computerized modelling process which reassembles digital microscope scans into a three dimensional object. Based on ethnographic data conducted in a UK environmental science facility, I follow the process of building a 3D animation, and show how seeing and interacting with the object is achieved through embodied practices of ‘tinkering’. These involve various hand-acts at the keyboard/mouse, as well as trial and error manipulations that allow users to get a ‘feel’ for the dimensionality of the object on the computer screen. The paper draws from recent research in science and technology studies (STS) which explores the role of gesture and corporeal engagement in digital image making (Myers 2008; Alac 2008), and argues that computer ‘seeing’ is not an intangible process, but is rather performatively enacted through manipulation and bodily interaction.

Julie Palmer and Frances Griffiths (University of Warwick): 'Digital radiography in the post-photographic era'

If we have entered the ‘post-photographic era’ (Mitchell) we are perhaps not yet post-radiography. It has been argued that the shift from chemical to digital photography has challenged the ontological and epistemological status of the image. Digitisation has made it possible to create an image without an original, has made extensive manipulation of the image possible, and difficult to detect. The necessary link between the image and the ‘real’ has been challenged, perhaps fatally undermined. Within medicine, analogue images on film have been replaced by digital images, displayed on highquality screens that can be extensively manipulated, e.g. to suppress noise in the image, or to increase contrast. Multi-detector CT can produce hundreds or thousands of axial images and these can be combined into 3D, or read in ‘stack’ (cine) mode; for certain organs, a ‘fly-through’ or ‘imagenavigation’ technique is used. Realistic 3D views of the body can include ‘unreal’ impossible viewpoints made possible by computerisation and mathematical calculations. Yet, the sociological literature around medical imaging has focused on realist tropes that reinforce the notion that technology can create a window on the inner body. Scholars argue that medical images have come to be seen as interchangeable with the body being scanned, rather than as a construction of it: they appear to reflect the inner body ‘as it really is’ and to therefore render it knowable and controllable. The ‘myth of transparency’ (Joyce, 2008) rests on a long tradition of positivist scientific endeavour that seeks to ‘reveal’ the natural world, without human mediation. Technologically extended vision and mechanically produced images lay claim to particular authority in knowledge production, perhaps none more so than those produced in scientific and medical contexts. Use of machines, such as Magnetic Resonance Imaging (MRI), Computed Tomography (CT), and Positron Emission Tomography (PET) come to symbolise progress, the ‘gold standard’ in care. However, it is argued that this belief in ‘mechanical objectivity’ (Daston and Galison, 1992) erases the human values and labour involved in image production, the social, economic and political context of the technology and its use, the sociality of knowledge production. Scholars have therefore critiqued this by drawing attention to the social and technological construction of radiodiagnostic images in clinical practice, particularly through ethnographic studies (e.g. Burri, 2008; Joyce, 2008).

The aim of this paper is to review the existing literature through the lens of technological change and to ask whether digitisation provides a further opportunity to challenge the ‘transparency myth’ (Joyce 2008). The paper will consider advances in digital image production but also image processing, image display, recording, storage and transmission. Could digitisation in medical imaging, as in photography, offer a heuristic tool for understanding representation and emphasise the social and technological construction of the body? Do multiple images of the same body, for example, each strikingly different in appearance, occasion more awareness of the role of technology and human labour in visualising the inner body? Could the visibility of pathology in some of these images but not others reinforce a social constructionist or semiotic analysis of medical imaging?

Luke Church and Alan Blackwell (University of Cambridge): 'Computation, visualisation and critical reflection' (Demo)

We are interested in creating novel representations of computation, so that people who are often excluded by traditional software development tools can access the power of computing. For example we work with artists who wish to use computational behaviours as an inspiration for dancers, or for sculpture, but lack the time or interest to engage with traditional programming languages. We also engage with social concerns such as online political activism, economic divides, cultural heritage, the 'e-sciences/e-humanities' and gendered conceptions of technology.

Rather than using our technical expertise to craft solutions one at a time for these audiences, we use particular engagements to inform the creation of tools that our collaborators can take forward and use by themselves, creating new products for their own audiences. In this way we reach a much wider constituency than would otherwise be possible.

The dominant discourse in computer science as to how to achieve this, is the advocacy and implantation of 'computational thinking' [Wing 2006], training others to think like computer scientists. We have chosen to reject this route [Blackwell et al 2008], starting instead from a critical reflection on metaphysics of computation [Smith 1996] and the politics of information structures [Bower and Star 1999], further developed through our own action research. This research has taken the form of extended technical engagements with several major global corporations. In each case, we have been involved in core aspects of the technical infrastructure strategy, contributing as specialist design consultants (unfortunately the sensitivity of these projects means that we will not be able to discuss them in any detail, or to name the companies involved).

We juxtapose our commercial activities with a programme of engagement in contemporary arts research and practice, studying and extending the varying design processes and requirements of leading artists such as choreographer Wayne McGregor and sculptor Bruce Gernand.

The outcome of this programme of technical engagement and critical reflection has been a series of interactive visual representations, seeking to explore different aspects of the experience of computation. Our aim is to allow users to explore the possibilities of computational behaviour in flexible ways, rather than limiting them to a series of predefined options constrained by the trivial 'metaphor' of direct manipulation interfaces, as is common in software design practice [Blackwell 2006a]. This goal might be expressed as the creation of a graphical 'programming language', rather than simply a graphical 'user interface', although the representations that we are creating are sometimes not recognisable to computer scientists as belonging to either class.

We are concerned that in rejecting much of the standard discourse from computer science, we run the risk of working without the rigour of a critical community. We are closely engaged (including as founders and convenors) in fields that take a cognitive stance with regard to visual representation use, such as the international conference on theory and application of diagrams, conferences on visual languages, and on psychology of programming. However, we would like to seek new feedback from other communities as to the philosophical and methodological foundations of our research.

We are very aware of the challenges involved in facilitating interdisciplinary encounters [Blackwell 2006b, et al 2009], and of the need for shared experiences, values or boundary objects in establishing new conversations. We therefore propose - if the conference programme and technical facilities allow - to offer participants the opportunities to experiment with some of the novel tools we have created in a 'hands-on' session. We think this could provide a stimulating basis for the discussion on the ways that visual representations can become notational tools for use in supporting a wide range of intellectual enquiry.

Paper session: Professionalised vision

14:00-15:30, Lecture Theatre 4

Chair: Paul Jepson (University of Oxford)

Phaedra Daipha (Rutgers University): 'Screenwork as the social organisation of expertise'

Despite the great variety of visual representations flooding the places of expert activity, there is no question that, today, they mostly reach their destination through computer screens. In effect, it is computer screens that have come to colonize the spaces of knowledge production and it is *screenwork* that now forms the backbone of expertise. In this paper, I explore the implications of the notion that current forms of expertise are acquired, produced, performed, and consumed on the basis of ICTs in general, and visualization technologies in particular. To illustrate and flesh out this position, I primarily draw on twenty-two months of fieldwork at a forecasting office of the National Weather Service. Weather forecasting constitutes an excellent site for evaluating visual perception at work. Weather forecasters are tasked with predicting the behaviour of a phenomenon that, while perceptibly present outside, cannot be physically manipulated and studied under controlled conditions 'inside.' Hence, the development of the meteorological profession has been contingent on finding ways to reconstruct the weather indoors, essentially co-evolving with the development of visualization technologies. It is no accident that atmospheric modelling was one of the first applications of computer visualization. Weather forecasters have been gaining in experience and authority by mastering the weather on progressively more dynamic, more weather-like maps. By following the forecasting task, one effectively beholds expert perception in action. In order to outline a framework for studying expertise as screenwork, I will be focusing on three distinct but interrelated aspects of visual perception: (1) practices of looking; (2) the acquisition of visual expertise; and (3) visual decision-making. In the process, I will be paying particular attention to how screenwork practices (re)structure the negotiation of skills and professional authority, the coordination of information and resources, the aesthetics of knowledge production, and the emergence and institutionalization of novel organizational fields in the so-called knowledge economy. By reformulating expertise as screenwork, I thus aim to systematize and expand ongoing debates in STS as well as the sociology of work and occupations around the technological transformation of the workplace.

Grace de la Flor, Marina Jirotka and Eric Meyer (University of Oxford): 'Accessing medieval music: from material codex to digital specimen'

The scholarly study of medieval music manuscripts has traditionally required that musicologists travel to libraries and museums where the artefacts of interest, the complete manuscript or fragments of manuscripts, are physically held. However, with the introduction of digital image archives scholars now have the ability to conduct much of their research through both the inspection and manipulation of digital images. We argue that increasingly digital image use in the humanities is extending beyond the *description* of visual images through the analysis of aesthetics and culture (e.g. art history and media studies) towards their respecification as research objects where 'technical work' is conducted in order to draw out and *expose information* that wasn't accessible before. We are finding that work conceived of as traditionally 'scientific' kinds of practices are nonetheless being adopted by humanities scholars especially in their use of digital image analysis software tools to manipulate, mark, categorize and compare features that reside within such images (Terras, 2006; de la Flor *et al*, 2010). The increased use of computational technologies within the humanities is transforming research processes and knowledge production amongst these scholars and so provides us with an opportunity to investigate beyond the sciences across a wider swath of academic disciplines.

Our focus in this paper is on a specific digital image archive - DIAMM (The Digital Image Archive of Medieval Music - http://www.diamm.ac.uk) where we discuss how the musicologists who use it conceptualise this shift in their study of physical objects mediated through the use of high resolution naturalistic photographs. The archive was originally set-up to support the conservation of medieval polyphonic music manuscripts dating from approximately 800 to 1550 to ensure that their contents may still be viewable in cases of their loss from natural degradation, theft and geopolitical difficulties to gaining access. However, increasingly musicologists are using the archive as a research tool and in the first half of 2010 we interviewed scholars distributed across three continents to discuss the ways in which they use DIAMM including the kinds of substantive research practices they conduct through digital image analysis software, its effect on their interpretation of images and the corresponding results of such work.

Within the DIAMM archive each image includes the following elements: a manuscript item, a colour patch and ruler. Both the colour patch and the ruler are placed alongside the manuscript to provide indications of its actual appearance and serve as objective supplementary elements in the rendering and translation of physical objects into digital form. The ruler indicates its actual size which remains consistent relative to the level of zoom and the industry-standard colour patch assists in determining if a user's computer monitor is calibrated correctly.

Through this display, each leaf or fragment of a manuscript is extracted from its context within a codex and is presented as a discreet scientific specimen. This is particularly interesting because well-known accounts, within Science & Technology Studies (STS), of scientists who use visual representations of physical objects have characterized their use as leading to, in the case of astronomy, a transformation of "observational field science to an image-processing laboratory science" (Knorr Cetina, 1992: 117). And, in the case of the UK systematics community, resistance to digital imaging technologies where existing material culture determined scientists' responses to an engineered virtual culture (Hine, 2006).

Both of these concerns - the transformation of fieldwork approaches into a laboratory-type science, and points of resistance to the introduction of new technologies are important topics in debates about the use of computational imaging within a range of research disciplines. Whereas in the sciences the use of digital images have been challenged on these grounds, in the humanities we find that the scholars using DIAMM appraise the properties of digital images as supporting and enabling their research goals.

More specifically, we found that digital images afford a kind of durability that enables detailed inspection and manipulation which would otherwise permanently damage or destroy the physical object. Additionally, digital images also provide a route into more elaborate manuscript analysis such as leaf textures, processes of book binding, pigments used, tracking its historical context, following the career of particular scribes, and the sounds that a series of musical notes might represent. In this way, the musicologists' approach to the use of digital images is similar to what Pink (2009) describes as the capacity of visual images to provide a route into multisensory knowing as opposed to being strictly defined as "observational and objectifying tools" (p. 99). Additionally, having access to a wide range of manuscript fragments within the DIAMM database makes possible the piecing together of broken up manuscripts where they were reused to make book bindings, chair stuffing, papering for ceilings and even hat boxes and musical instrument cases. These fragments are located across the entire European continent and beyond. Having access to their digital images makes it possible for scholars to compare them and to identify those that may belong to the same manuscript.

In what follows, we present detailed examples of the ways in which digital images are transforming research practices in musicology and the manner with which they afford; durability to enable detailed inspection, routes into multisensory knowing and the linking together of heretofore disparate manuscript fragments. From this, we conclude that the introduction of laboratory-type practices where digital images serve as a mediation device between the scholar (the musicologist) and the physical object (the manuscript) has subsequently had a more positive effect for musicological research and provides opportunities for new ways for revealing the details of and interpreting physical objects.

David Ribes (Georgetown University): 'Redistributing expert vision: crowdsourcing, agency and interface'

In 1987 Nadine Barlow, a graduate student in planetary geology at the University of Arizona, completed her year-long survey of all the large craters on Mars using the satellite imagery collected by the Viking spacecraft. Within geological studies of solid bodies in our solar system, crater mapping can serve multiple purposes. In this case Barlow was concerned with generating a chronology for Mars using surface based planetary events as markers. An 'absolute chronology' for Mars is only possible with lab based studies of rock samples, but it is possible to compose a 'relative chronology' by using surrogate markers such as crater densities and stratigraphic relationships on the surface of the planet. To do so Barlow executed a mapping of craters on the surface of Mars:

> I have divided the surface of Mars into 23 geologic units based on existing Mariner 9 geologic maps and extensive remapping using the Viking 1:2M photomosaic series . I mapped and measured 42,283 craters over the entire surface of Mars, and classified them by location, ejecta and interior structures, and, if applicable, degree and orientation of ellipticity and relationship to tectonic features. Out of these 42,283 craters, the 25,826 craters which are ->8 km in diameter were used in the following crater statistical analysis.

This was Barlow's dissertation. She describes spending over a year reviewing the imagery of the Viking spacecraft, individually measuring and the classifying each crater. She then drew on this data to generate a new chronology of Mars.

Starting in November 2000, and completing in September 2001 the NASA Clickworkers pilot project facilitated the same task Barlow conducted by distributing work to thousands of volunteers and producing comparably accurate results. In the words of its designers, clickworkers is:

> an experiment that showed that public volunteers (clickworkers), many working for a few minutes here and there . . . can do some routine science analysis that would normally be done by a scientist or graduate student working for months on end.

Clickworkers was NASA's initial attempt to distribute astronomical research through a web interface. Using their mice, members of the public contributed by tracing meteor craters on satellite images of the surface of Mars, populating a database by sending results back to NASA. Identifying craters in satellite images is beyond the capacity of today's computing systems but quite easy for humans. The system drew on the clickwork of thousands of volunteers, relying on their human perceptual systems to interpret image files. Clickworkers is also a game, 'incenting' its users to greater performance through scoring and competition. As they worked away at their home computers, sending data back to NASA, clickworkers were rewarded (or punished) with points rating their performance and an arcade-style 'top 100' ranking system which compared all clickworkers.

In the words of its NASA designers, Clickworkers was "a pilot study with very limited funding, run part-time by one software engineer, with occasional input from two scientists". Despite these limited resources by the end of the pilot project, clickworkers had classified the topology of Mars' craters with comparable accuracy to Nadine Barlow's survey work.

How could an anonymous ‘public’ conduct work which was, until the advent of the clickwork interface, the domain of astronomers and geologists? How could the average internet user produce interpretations of images that carry authority within scientific circles? Drawing from work in scientific visualization studies and in particular Charles Goodwin’s canonical article ‘Professional Vision’ I will trace an emerging reconfiguration of expertise as coding, highlighting and the creation of visualizations come to be redistributed through a web based application. Redistribution is not the take-up of all work by machines -- as the term automation implies -- it is a choreographed reorganization of human work and analytic. In the second section of this paper I will place such redistributions within a historical lineage of scientist/technician relations within astronomy and in particular focus on the techniques and technologies for disciplining the amateur observer. Clickworkers look more like technicians than citizen scientists. Finally I will conclude with a discussion broader discussion of ‘crowdsourcing’ and ‘citizen science’ by exploring the emerging base of knowledge within HCI and CS (human computer interface and computer science) about ‘how to distribute’ scientific work to lay people while producing authoritative results.

Paper session: Visual practices of objectivity

14:00-15:30, Lecture Theatre 5

Chair: Torben Elgaard Jensen (Technical University of Copenhagen)

Chiara Ambrosio (University College London): 'Objectivity and representative practices across artistic and scientific visualisation'

Lorraine Daston and Peter Galison's work on scientific atlases has opened new lines of inquiry into the relations between objectivity and visual practices in the sciences. Implicit in their narrative, and perhaps worth of further investigation, are some interesting suggestions on how historical reflections on visual practices incorporate the evolving relation between science and art. Their model of truth-to-nature places artists in the position of mediators between nature and the will of the naturalist in the pursuit of capturing reasoned images on the pages of scientific atlases. Mechanical objectivity, and especially the advent of photography, saw artists and scientists divided over the role of mechanically produced images. Structural objectivity, or "objectivity without images", denied artists a space in the scientific endeavour and privileged formalization as a means for the construction of a universally communicable scientific language. Trained judgment, conversely, seems to offer a ground for reconciliation between artists and scientists – and indeed, the perspicuity of the interpreted scientific image has an artistic counterpart in 20th century avant-garde, which is exemplified by the well documented relations between modernism and science. Yet, Daston and Galison's narrative stops at a point that seems to mark a crucial juncture in the history of visualization: the contemporary shift from "representation" to "presentation", which they discuss within the context of visualization at the nanoscale. "Nanomanipulation" challenges the boundaries between the the artifactual and the natural, so that the new scientific images fulfil the purpose of manipulating the real – and they do so in an aesthetically pleasing way.

In this paper, I address some epistemological questions arising from the epilogue of Daston and Galison's historical narrative. What is the new form of objectivity arising from visualization at the nanoscale? In addressing this question, I suggest to take a more careful look at the history of visual practices across art and science. I suggest to do so by adopting a pragmatist standpoint, which requires a reconsideration of representations as constitutive components of scientific experimentation. With this aim in mind, I suggest to shift the focus of philosophical inquiry from a concept of "representation" to a pragmatic view of "representative practices", considered as the means and strategies through which artists and scientists devise useful and perspicuous ways of exploring and intervening upon phenomena. This emphasis on the practical aspect of representing is a key feature that computational visualization in science shares with artistic experimentation, especially when it comes to the contemporary artistic tendency to embed "data" in installations and digital artworks. Thus defined, a concept of representative practices may help defining a new chapter in Daston and Galison's history of objectivity. For one thing, it may help individuating the key boundary areas in which art and science continue to complement each other. At the same time, the epistemological shift from representations to representative practices may contribute to cast light on the ways in which the new (experimental) aesthetics of computational seeing directs artists and scientists in articulating practical judgments about their working objects.

Bill Leeming (OCAD University): ''Computationally seeing' an epistemic space for genomic medicine'

Elsewhere I have explored early techniques used to visualise the genetics of disease in relation to the formation of a new medical specialism (i.e., medical genetics) (Leeming, 2010; 2011). The earlier work revealed a thread of underlying continuity of aims and objectives connecting the production of early graphical techniques to visualise the genetics of disease to contemporary computationally intensive techniques for storing and accessing genetic information. Here, a variety of visualisation and storage techniques accrued in the translatory movement from the use of family records and pedigrees in ostensive systems to represent episodes of familial disease through to the advent of new laboratory technologies for studying chromosomal anomalies and genetic metabolic disease and, subsequently, the development of molecular biological techniques of analysis. New ways of thinking about heredity and disease consequently emerged alongside new working roles for geneticists in medicine.

This paper goes on to investigate computationally intensive techniques for data visualisation in genomic medicine (i.e., medicine studied from a genomic post-genomic perspective). As new technological advances continue to drive down the cost of genomic sequencing, medico-scientific researchers across a broad range of disciplines, subdisciplines, and fields of study have begun to use large-scale sequence data as a tool for studying disease. Correspondingly, alongside conventional data browsing and storage systems, digital tools are being produced for 'computationally seeing' a variety of model organism genomes (including humans), complete chromosome sets, sequence maps with contigs (i.e., a series of overlapping clones or a genetic sequence defining an uninterrupted section of a chromosome), and integrated genetic and physical maps. With specific regard to visualisation, genomics has a broader and more ambitious reach than does genetics (cf. Scheuner *et al.*, 2008; Feero *et al.*, 2010; West *et al.*, 2010). Here, I pick up where Daston and Galison (2008) left off in their study of objectivity, specialised craftspersonship and mechanical forms of scientific documentation to explore how digital tools for genomic visualisation are openly performative in nature. I argue that in addition to allowing for active manipulation of information versus passive observation on the part of the viewer, the culture of knowledge transfer and information sharing practices associated with 'computationally seeing' shows all the signs of creating a new kind of epistemic space that intervenes to attenuate older distinctions that exist between medico-scientific disciplines, subdisciplines, and fields of study.

Matt Spencer (Goldsmiths): 'Image and imagination in computational modelling of fluid dynamics'

What role do images play in the research processes and technical systems of contemporary computational physics? Drawing on ethnographic fieldwork with one of the world's leading applied modelling research groups, I will explore the various ways in which images and visualisation techniques are deployed in practical scientific work.

It emerges that images in this setting consistently take a form analogous to that of the traditional epistemological object, a static and separate entity, separated in relation to the contemplating viewer. This presents an interesting challenge in light of recent calls from social scientists such as Tim Ingold and Bruno Latour, for a theoretical move beyond the object, towards "the thing".

I will tackle this challenge by sketching a broader history of the displacement of the object from its axiomatic place at the heart of epistemology, concentrating particularly on how this happens through the work of Gaston Bachelard and Martin Heidegger. Drawing on Bernard Stiegler's post-phenomenological theory of technics, I show that the challenge for contemporary STS is not to displace the object, but rather to account for the processes of objectification, the particular modes of genesis of objects within technical systems. Stiegler's philosophy can show us that these objects are not illusions, but that they can easily *give rise to* illusions due to their "mnemotechnical" and "pharmacological" character.

Paper session: Science and aesthetics

14:00-15:30, Seminar Room A

Chair: Martin Kemp (University of Oxford)

Roberta Buiani (University of Toronto): 'Of viruses, microscopes and computing: visualisation and the question of biopower'

Increasingly sophisticated methods are used today to explore the world of the microscopic. Of the variety of microorganisms that have been immortalized using a number of technologies (electron microscopy, modeling etc..), viruses are among the most fantasized about. Their size and nature makes finding appropriate visualization models and methods of analysis rather challenging. As a result, visualization becomes highly diversified, as attempts to portray these submicroscopic substances using proprietary and open source computing and a vast range of technological instruments abound and often compete with each other. This paper reflects on the above diversification. It argues that the recent blossoming of scientific visualization that reproduces, simulates and represents viruses reveals, and simultaneously defies, default regimes of knowledge and normative rules that characterize the management and dissemination of technoscientific content regarding viruses.

On the one hand, visualization tends to incorporate elements that domesticate the object of study and effectively regularize or marginalize images of viruses displayed in science and popular culture, by adapting them to fit default agendas and recommendations. In addition, despite its increased use to document today's viral incidents and its current popularity, scientific visualization seems to struggle to obtain a legitimacy of its own, its products still being used as accessory objects, accentuating the most common assumptions that dominate the general discourse on viruses, namely, their disruptive and terrifying potentials.

On the other hand, scientific visualization manifests a desire to defeat and overcome the above regime of control through the quick and continuous production of newer and more innovative techniques, or through the introduction of critical ways to represent viruses that leave behind popular notions of contagion and infectious diseases.

These clashing trends locate the scientific visualization of viruses within a biopolitical discourse. Neither visualization nor its object of study are definite or emanate from a fixed institutional/scientific system. Both visualization and viruses can be defined as distributed systems. Socio-cultural assumptions, professional dynamics as well as the deployment of a variety of instruments (microscopes, techniques of staining and preparing the samples) and technologies (both software and hardware) play a crucial, yet very different role in the production of scientific visualization. The aesthetics of scientific visualization is continuously adjusted as newer information about viruses and the disease they carry arise, and as different circumstances require yet another type of visualization method.

A sustained analysis that takes into consideration the intertwining and relations between the above aspects and, thus identifies scientific visualization as a cultural object, rather than purely a set of technologies, a bundle of software, or just aesthetics, can not only expose the socio-political dynamics involved in the production of scientific visualization of viruses, but also expose, even challenge unquestioned assumptions and hidden agendas involved in shaping the discourse on viruses. By mapping the scientific visualization of viruses through its relation to the publications (journals or magazines) that host it, as well as the technologies and techniques that proceed it (SEM and TEM, modeling software etc..), this paper aims to demonstrate how the variety that characterizes scientific visualization functions not only as a symptom, but also as an act of rebellion and resistance against its own standardization.

Sara Diamond (OCAD University): 'Aesthetic histories and material practices – the limits of visualisation and the limits of the real'

This paper proposes that differing understandings and dependencies regarding scientific realism shape the approaches of scientific, information and art visualization. It is the representational act of transforming data structure into a visualization interface that allows the user of the visualization to interact with the data. 'Data' are both an abstraction and mediation of actual phenomena. Whitelaw describes data as 'a set of measurements extracted from the flux of the real [that] are abstract, blank, meaningless' that become information only when they are placed into an interpretive context. Different disciplines and fields within these disciplines have distinct understandings of where and how mediations play out within the process of visualization. The rationalist roots of scientific realism suggest that perception leads directly to action, and presupposes the alignment of reality and image. Scientists have expressed both skepticism about the subjectivity inherent in building visualizations and a yearning that the image be as close to an assumed truth about the matter represented. For example Pierre Boulanger et al. argue that it is necessary to keep the metaphor close to the look (whether observed or photographic) of the data's source. Visualization then becomes the means to make the invisible visible.

This paper evaluates visualizations within a history of aesthetics that is shaped by diverging relationships to realism and instrumentality within art, design and science. These analyses are particularly acute in relation to large data sets that do not have as a referent a photographic instrument and image, which otherwise no matter how obscure, can act as a reminiscence of materiality, shaping the imagery used in the resulting visualization. The relationship to the photographic, it's historic role and reading as and within scientific instruments is one point of differentiation between information and scientific visualization. A challenge to realism occurs when the source cannot be seen, only measured and then imagined. In fact, entire new practices that cross the boundaries of information and science, such as genomics and bioinformatics have come on stream. These fields rely on data visualization to excavate structures in large-scale data sets. They have no photo realist technologies to fall back on. Secondly, as Lev Manovich has remarked, data visualization allows representations to be mapped onto each other, to compare and overlay vastly different data sets, permitting the representation of infinite permutations and complexity.

Data visualization represents a set of codified practices with material consequences that engage with the history of aesthetics suggested earlier. I have used the notion of 'data drive design' within visualization practice to suggest that data is a material with specific properties that frame and limit the possibilities of expression, through the indexical relationship between source data, structure and image. But is the indexical nature of data structure similar to the structuring effects of clay or paint on the final art work or does it bear down on potential images in a different way? The pattern-seeking activity that is fundamental to visualization aligns with previous generations of practitioners in science and art who invoke realism and modernist abstraction. This paper considers the relationship between data sources, the mode of data extraction, the structure of the data and its representation, to better understand the point where materiality, practices and aesthetic assumption convene or conflict.

These questions are pertinent to The Centre for Information Visualization and Data Driven Design, a multi-institutional research centre that brings together a core group of twelve artists, designers, cultural theorists and ethnographic researchers with scientific researchers in the fields of computational linguistics, cognitive science, data extraction, artificial intelligence and data visualization. The Centre operates on the premise that artists, designers, humanist scholars and scientists will each bring differing methods and ontology to materiality, mediation and imaging, creating fertile ground for new kinds of visualizations, perhaps provoking new insights about the source data as well as aesthetic expressions that have intrinsic value. The aesthetics of scientific realism may create limits to imagination, tying visualization too tightly to analytic reasoning' which could fail to deploy the transformative power of visual experience. Hence a theme within the Centre is the ongoing and explicit investigation of data visualization aesthetics.

Anja Johansen (NTNU): 'The sublime aesthetics of the cell'

In an interview in the 90ies filmmaker David Cronenberg joked about a future in which we might have ".. a beauty contest for the inside of the human body where people would unzip themselves and show you the best spleen and the best heart."(Quoted in Jenkins 2006). As far as I know beauty contests for body organs the way Cronenberg imagined doesn't exist. However, what we do find today is a growing number of "beauty contests" for scientific images from the inside of the body, contributing to making the human body's microcosm visually available for a wider public.

In this paper I will present and discuss a selection of winner images from one of these scientific imaging contests; the Wellcome Image Award. The contest is arranged by the Wellcome Trust in Britain, whose aim partly is to promote medical research to the public, and therefore seems to rely on the affective potential of striking scientific images. The winner images, "..the most informative, striking and technically excellent images..", are selected by a panel of expert judges from different fields, and the images are created using techniques ranging from light and electron microscopy to illustration and photography. First, I will try to sketch out an aesthetic of the winner images presented in the Wellcome Image Award, focusing on images of human cells. In the analysis of the images I will address the 16th and 17th century concept of the sublime, by Kant used to describe the subjects encounter with vast or wild landscapes. Turning to the inner, microscopic landscapes of the body, I will highlight the relevance of the microscopic images' emotional effect on the viewer, in other words their affective value. Another interesting aspect of the contest is the mixing of scientific, aesthetic and technical criteria in the selection of the winner images ("informative, striking and technically excellent"), since these criteria are often seen as belonging to different judgmental spheres. I will argue that in the case of the winner images, and possibly for other scientific images made for public communication, the affective value of these images not only depends on formal aspects of the image (the use of color, contrast, composition, lines etc), but is also due to the public amazement over the technical possibility for depicting such microscopic phenomena, as well as the myth of science as a modern salvation practice (Mary Midgley 1992).

Paper session: Ethnographies of the visual

16:00-17:00, Lecture Theatre 4

Chair: Udi Butler (University of Oxford)

Marko Monteiro (University of Campinas): 'Are scientific images good ethnographic sites? Interpreting remote sensing practices in Brazil'

This paper explores data collected in an ongoing ethnography of remote sensing practices in Brazil. I also relate these data with analyses done in the context of a previous research project, an ethnography of computer modeling practices in the US (Monteiro, 2010a; Monteiro, 2010b; Monteiro and Keating, 2009). The argument I put forth is that the increasing pervasiveness of digital images in scientific practice is shifting how scientists relate to and build scientific evidence, which suggests a need to rethink how STS scholars approach these topics. Such shifts involve a) how visual representations relate to the empirical as scientific evidence of natural objects and phenomena; b) how scientist construct scientific evidence from visual tools and objects through laborious interpretive exchanges; and c) how embodied interactions with visual representations becomes central in understanding scientific images. These developments suggest that STS should focus not on the visual per se as the explanatory arena, but on the relationships established by scientists between images/digital objects, technological tools and realities. In methodological terms, I will argue also that ethnographies of scientific visualization practices in science are well positioned to answer these heuristic challenges by enabling the mapping and interpretation of these associations and how they work not only to represent, but to help (re)construct realities inside and outside of scientific settings.

The acquisition and interpretation of satellite images are only one kind of remote sensing practice, but are becoming more and more central in geosciences in Brazil. As these sciences shift to more technology-based methodologies, there are increasing efforts from the government and universities to expand infrastructure (launching satellites and acquiring advanced computing facilities) in order to refocus the research in computerized terms, seen as more precise and powerful. This means that the production of scientific images is becoming the dominant language of representing geo-scientific knowledge in a sense, even as it still relates closely to traditional field methods. Such knowledge is becoming a valued commodity in this country as a tool to map and curb deforestation, organize agriculture and manage the newly discovered oil wealth off the coast, among many other examples.

The building of "usable" (meaning scientifically meaningful) images from "raw data" coming from the satellites involves, in the cases I am analyzing, the construction of meaningful contrasts in the image. Such contrasts enable scientists to establish, for example, sites of deforestation in Brazilian forests, among a number of other variables of interest to remote sensing teams. In terms of how images participate in scientific practices, they are far from direct and intuitive ways of producing knowledge: on the contrary, the growth in importance of scientific visualization seems to have brought back the need for extensive "manual labor" in the precise deciphering of what these images mean. Building usable scientific images is thus not distinguishable from building scientific evidence itself, be it in the case of computer models or in meaningful satellite images. Far from merely visual, the modes of scientific work deployed are very much embodied, as far as the interactions established by the scientist with each other and the images (usually via computerized tools) are a necessary step to building scientific images/evidence.

Digital images seem to also reinforce mechanical objectivity. This helps to understand both how these images become materialized as evidence in scientific settings, and how important they become in circulating knowledge through media channels. To answer the question posed in the title: Yes, scientific images can be good sites for STS oriented ethnographies, insofar as they enable the refocusing of science as a representational problem, reconnecting knowledge, images and realities in new and rich ways. But they can also be misleading sites, if scholars focus on images in a strictly "visual" paradigm, ignoring the plural relationships involved in building such representations and in understanding their associations with realities. The challenge of opening the "black box" of scientific representation through digital images, increasingly being tackled by STS scholars around the world, helps to further our comprehension of scientific representational practices and adds to this by enabling a richer understanding of how realities are built inside and outside of scientific settings.

Daniel Neyland (Lancaster University): 'Notes from an ethnography of deleting'

The massive and rapid growth of digital surveillance technologies over the last fifteen years has inspired a range of questions regarding the visual images produced and held in digital information infrastructures. First, there are questions regarding the apparent capacities of these systems to carry out automated analysis of pixelated images: can these systems use, for example, facial and gait recognition, iris scanning and programmed algorithms to detect known individuals or suspicious behaviour? Are the images produced of sufficient evidential quality for legal action? Second, there are questions raised in response to concerns regarding civil liberty and privacy, ethics and accountability, such as is it possible to regulate rapidly changing digital CCTV? How many cameras are there and how many images, kept for how long, accessible to whom and used for what? Answers to all these questions are frequently proposed and just as frequently challenged.

However, taking into account: the mass of images only few of which can ever be looked at in detail; the apparent ability to pick out suspicious behaviour and known individuals (through gait and face recognition); the civil liberties, privacy, ethical, accountability and regulatory concerns from holding millions of digital images; and that images are stored in one place, in a digital drive; why not gather together the vast majority of images of non-suspicious behaviours, uninteresting individuals and irrelevant footage and press delete?

This question provides the starting point for a project which ethnographically engages with an academic-industry coalition developing ‘digital deletion solutions’. The coalition involves University technology experts in the design of digital CCTV algorithms, major producers of digital information infrastructures through which CCTV systems operate and users of CCTV in public transport and security settings. Although conceptually, deleting may appear straightforward – select the data to be deleted and press delete – it turns out to be a messy and complex organisational challenge involving many of the same questions that are posed of CCTV systems more generally. Questions of, for example, who has *not* done what, who does *not* require scrutiny, how long does an image *not* need to be kept for, are just as complex as their opposed counterparts. This paper will engage with the emerging social science literature on deletion and use the ethnographic research to take up three elements of the complexity of deleting digital images to begin an analysis of the no-longer-to-bevisual.

First, questions arise as to the creation of irrelevance. Designers of the digital deletion solution suggest that a combination of algorithms to select the gait recognition of known trouble-makers and software that can separate out suspicious actions will enable a vast amount of irrelevant ‘nonsuspicious’ data to be deleted without CCTV operatives even seeing the images. That such systems will also send to CCTV operatives a certain amount of irrelevancy (images that turn out not to be of the known individual, behaviour that turns out not be suspicious) is expected and will result in operatives being able to delete further images after a quick glance. At least in theory. An enormous effort is required to set up digital CCTV systems so that scale is equivalised across different cameras in different parts of a system. In situations where equivalisation can be made to work, the recorded gaits of known offenders will most likely only be available from those individuals who have previously been recorded on this system. There is no generally available digital record of offenders’ gaits. Furthermore, if a known individual has put on or lost weight, had an accident or injury, is in a funny mood, wearing a large coat or carrying something, their gait may change either intentionally or unintentionally. False positives can be rejected by CCTV operatives, but false negatives may never make it to their attention. Similar questions arise with selecting out suspicious behaviour. Accomplishing irrelevancy is by no means straightforward.

Second, questions arise as to what is meant by ‘deletion.’ One might imagine deletion to mean the expunging of visual images from a digital system. However, more frequently, deleting involves either changing the location of digital images or changing the route by which a digital image is retrieved. In place of expunging, come questions of for whom an image or set of images ought to be inaccessible. In this sense, ‘deletion’ may mean CCTV operatives, for example, are prevented via re-routing, from accessing visual images. This is not the same as saying the images are removed from the system. One of the most frequent uses of CCTV images is in retrospective reconstructions of society for a particular time and place. For example, if a terrorist attack occurs, CCTV images are seldom used to prevent the attack, but can play an important role afterwards in attributions of guilt, tracing known associations of the guilty, providing information to public inquiries and accomplishing accountability for those involved. To delete – in the sense of expunging – digital CCTV footage risks undermining some of the functions for which the systems are most heralded. Accomplishing a definition of deletion (what kind of expunging, at what time, coupled with what kind of initial re-routing and for whom) is challenging.

Third, detailed questions are asked of the information infrastructure through which digital images move, become stored, viewed and 'deleted.' Alongside the generation and deletion of CCTV images, which build on visualisations of suspicious walking and other dubious behaviour, visualisations of the system as an architecture or information infrastructure are equally important. Designing the system as data focused (starting with algorithms and images and building up) or infrastructure focused (starting with route maps and feeding images in); utilising a white-list (a system with limited capabilities which then acquires permissions) or black-list design (utilising a flexible architecture and then creating blocked passages); figuring out firewalls (what and whom to allow movement); evidential chains of custody (who and how many should be enabled to see what); storage media (as part of or separate from a network); and externalisation of data (as a managed crossing of boundaries); are decisions which each have a role to play in accomplishing deletion.

The full paper will provide a more in-depth analysis of these three areas. It will then conclude with some initial suggestions on managing the ethical accountability of creating the no-longer-to-bevisual in order to open up discussion.

Paper session: Visualising controversies

16:00-17:00, Lecture Theatre 5

Chair: Noortje Marres (Goldsmiths)

Brigitte Nerlich and Kate Roach (University of Nottingham): 'Pictures, politics and persuasion – the case of Greenpeace's Sinar Mas campaign'

Politics is based on persuasion. To be politically persuasive and to influence political decision making, public perceptions and social and economic policy in a modern world depends on gathering and distributing information, efficiently, effectively and, if necessary, emotionally. This information is increasingly visually designed and delivered through digital and social media. Information researchers have stressed that the visualisation of information "is not the mere decoration of factual information. It is elemental to the construction of meaning and how it is perceived. It's what Richard Saul Wurman calls 'the design of understanding'" (Prichard, 2010). Construction of meaning and understanding through visual representations can take many shapes and forms. We will concentrate on two forms of visual representation, which were used in Greenpeace's Sinar Mas campaign: images and videos on the one hand and visualisations in the sense of data visualisation on the other.

Over the last year or so Greenpeace has campaigned vigorously against deforestation of rain forests in Indonesia for the production of palm oil, with a focus on Sinar Mas, a major palm oil producer and supplier. The campaign targeted various users of palm oil, such as Nestle, Burger King, Unilever, the HSBC and many more. All those just mentioned have now stopped using palm oil from Sinar Mas. To achieve this Greenpeace used a variety of emotional images, amongst which reworkings of the Kit Kat brand were particularly potent; they will therefore be analysed in a first part of this paper.

Greenpeace also used viral marketing techniques and exploited the power of the social media, especially Facebook. Their success in this campaign was then charted by Salter Baxter, a communications consultancy, through a visualisation of the influence it had on the web. The resulting map (using the now ubiquitous 'blobs' and linkages form of visualisation) appeared on a Greenpeace blog published on 28 October 2010 with the subtitle:

> Is it a tube map for spiders? A diagram of the galactic core? No, it's an analysis of our ongoing Sinar Mas campaign, specifically the way it has evolved online. (http://www.greenpeace.org.uk/blog/jamie)

The blog does not make clear how to read or understand this 'map', but instructions can be found, if one searches enough, in another blog and in a *Guardian* article reporting on the map. But even without understanding the real meaning of the map, the map has a persuasive force. It says: Look here, what we have achieved! Although initially used to just 'track' political debates, political influence and political publics, such visualisations can become media of political persuasion themselves. The 'Sinar Mar Influence Map' will therefore be the focus of the second part of our paper which will attempt to track its use as tool of political persuasion, related to but different from images of Kit Kat packages destroying rainforests and their inhabitants, especially orang-utans.

The overall aim of the paper is to examine critically how visual persuasion can be achieved by two types of visual representations: emotive images and beautiful data visualisations, each aiming to design its own understanding by appeal to a different interpretative repertoire in the audience.

Tom Schilling (MIT): 'Kriging and traditional ecological knowledge: the visual politics of uranium exploration in Arctic Canada'

As global politics and environmental movements have shifted the critical focus on uranium mining from nuclear war and land remediation to green energy and containment, different standards of information, transparency, and expertise have been demanded of uranium producers. Over the same period, improvements in aerial survey methods, drilling techniques, and statistical algorithms for processing geochemical data obtained from soil samples have improved the precision of speculative exploration projects while lowering costs, reducing the impact of these activities on the physical environment, and facilitating surveys over vast areas in increasingly fine detail In the Kiggavik region of Nunavut in Arctic Canada, protests against uranium exploration have exposed gaps in the ways different forms of evidence are being treated by the mining regulatory process. Between 1988 and 2010, mining companies have repeatedly succeeded in bypassing public debates and expediting environmental impact assessment reviews during exploratory work by pointing to the minimal drilling and soil sampling required by contemporary methods for computerized geophysical simulation and ore body visualization. These debates have involved different strategies for articulating threats and rewards, and markedly differently visual languages for making the unseen visible. “Kriging,” a popular mathematical method for interpolating ore concentrations based on variations in obtained samples, exemplifies the ways in which visualizations of computer simulations based on minimal, low-impact field diagnostics have facilitated the production of compelling pictures of invisible ores. The spread of kriging has helped move the markers of geophysical expertise away from field experience and into the realm of statistical technique. Conversely, opponents of uranium mining have pushed for new maps, regulations, and political venues in which to supplement the conventional and scientific language of anti-uranium activism with irreducible, experiential forms of traditional ecological knowledge (TEK) gathered from Inuit residents in the Kiggavik region. I will argue that the distortions required to incorporate TEK into computerized visualizations forcefully demonstrate the epistemological limits of statistical ways of seeing. These translations are profoundly changing the politics of development and environmental conservation in indigenous communities.

By using published ethnographic accounts and records of public discourse over the past thirty years, I will compare the tone of debates around proposed exploration sites in Nunavut, community surveys in towns around existing mines in Saskatchewan, and conversations surrounding protracted reparations lawsuits and emergent claims on Navajo reservations in Arizona, showing their engagement with “kriged” forms of geostatistical evidence. I will show how the language of land access has begun to move away from the rhetorics of land rights and self-determination and into geospatial distributions of risk, containment, and economic development. Whereas disputes over development proposals could rely on the political moment of principled opposition to nuclear arms development, current protests must articulate counterarguments in increasingly technical, and increasingly visual, terms. I will provide a brief outline of the current conflict over proposed exploration in Nunavut by focusing on the contrasting roles played in the conflict by different uses of visual materials in industry-, government-, and activist-led efforts at community education. Initial attempts to explore for uranium in Nunavut encountered the momentum of the indigenous movement for self-government, which saw the end of the free-entry system of land development with the Land Claims Agreement in 1993 and the creation of Nunavut as an independent territory in 1999. In recent years, regulatory procedures in place there have become less ideological and more bureaucratic, while mining industry conventions for mapping invisible ore bodies and representing risk management have moved towards greater usage of computer-aided visualizations and statistical simulations. Rules for certifying land claims now focus on assessing immediate, quantifiable environmental impact, thus making the burden of proof for protests a matter of collecting, organizing, and making visible experimentally-obtained data.

Early conventions for representation in the geological sciences were heavily informed by physical encounters and modes of visual apprehension (Rudwick 1976). Contemporary conventions for data reduction, computer simulation, and visualization in some of the fields relevant to uranium mining, however, tend to rely on both haptic images and virtual assemblages of visualized, and often “kriged,” data (Daston and Galison 2007). Planning mining projects relies upon elaborate syntheses of many different kinds of data, each of which are compiled through statistical extrapolations from experimental or simulated measurements, and each of which appeals to different notions of technical, regulatory, and social legibility (Scott 1999). Hydrogeology, mining engineering, risk assessment, cartography, biogeochemistry, wildlife ecology, and aerial radiological surveying each have their own histories of deployment and mechanisms for enrollment in the Arctic (Latour 1990). The process of compiling maps for mineral speculation, planning, and political representation is increasingly driven by computerized methods and constrained by aesthetic criteria with substantial implications for future interpretation and use. Relying on algorithms for the visualization of uncertain information has thus raised the stakes for mineral futures and civic debate over conservation and resource use (Monmonier 1997, MacEachern 1994).

For cartographers, Inuit representatives, and Canadian government officials, incorporating experiential knowledge into mapmaking and technocratic policymaking has meant striking uneasy compromises for inclusion. Inuit-led measures to exclude land from mineral exploration and development have occasionally involved strategies for mapping burial sites, a distorted act of commemoration calculated to earn a preliminary position from which to advocate for new terms of representation and co-management (Houde 2007). Published ethnographic studies of the relationship between TEK and other forms of information derived through experimental and statistical methods have focused on changes in Inuit epistemologies influenced by increasingly frequent social, political, and intellectual encounters between Inuit and climate change scientists (Bielawski 1984, Laidler 2006, Fondahl 2006). By promoting TEK while lobbying scientists to reciprocate knowledge exchanges with Nunavut residents, Inuit anti-uranium protesters and climate change activists have effected an awkward, partial recognition of “kriged” data and its attendant politics. Taking care not to essentialize either form of knowledge production, I will use these accounts to critique the different forms of value attributed to experiential TEK and visualized statistical data, and to contrast their functions as vehicles for ideologies of development and expertise (Mitchell 1990).

Keynote speakers and discussants

Anne Beaulieu’s work focuses on the relationship between knowledge and technology. She is interested in the way new objects, and ways of knowing and communicating about knowledge, develop as technologies are taken in up in research practices. Current research areas are visual knowing through digital images, new research methods for mediated ethnography, social technology and
‘e-research’.

Peter Galison is Joseph Pellegrino University Professor and Director of Collection of Historical Scientific Instruments at Harvard University. The central component of Peter Galison's work involves the exploration of twentieth century microphysics (atomic, nuclear, particle physics). In particular, he examines physics as a closely interconnected set of scientific subcultures: experimenters, instrument makers, and theorists. More recently, he has been interested in the long-standing competition between image-producing instruments such as bubble chambers, cloud chambers, and nuclear emulsions on one side, and the "logic" devices such as counters, spark chambers, and wire chambers on the other. Professor Galison is now turning to a history of postwar quantum field theory, in which he views QFT as a "trading zone" between different domains of physics (e.g. particle cosmology, mathematics, condensed matter physics). On the side, he has tried to examine links between the history of science and neighboring fields - how, for example, historians of science and historians of art share methods and strategies.

Michael Lynch is a professor the Department of Science & Technology Studies at Cornell University. He is trained in sociology, but has worked in interdisciplinary departments for much of his professional career. He was one of the first social scientists to conduct an ethnographic study of laboratory research, and has published widely on laboratory discourse, legal uses of scientific evidence, and visualization with optical and digital instruments. He was co-editor (with Steve Woolgar) of *Representation in Scientific Practice*, and is currently working on visualization in nanoscience/nanotechnology. Since 2002, he has been Editor of *Social Studies of Science*, and was President of the Society for Social Studies of Science in 2007-09.

Paolo Quattrone studies accounting and management techniques for their visual power and ability to engage the user rather than simply for their aid to rational decision making. Successful techniques such as the Balanced Scorecard, Strategic Maps, 6-Sigma and information technologies such as Enterprise Resource Planning systems all rely on various forms of visualization and rhetorical techniques which help managers to imagine new business, how to align strategy and performance and the like. Paolo is currently working on the analysis of the visual and rhetorical techniques which allow the spread and success of management, governance and accountability practices. He has been recently granted a Fulbright New Century Scholar Award to study the future of business education in collaboration with colleagues at Stanford University.

Steve Woolgar is Professor of Marketing and Head of Science and Technology Studies at the Institute for Science, Innovation and Society, Saïd Business School, Oxford University. Steve has published widely in science and technology studies, social problems and social theory. He is currently conducting a project on Neuromarketing with Tanja Schneider that will examine practices and claims made by some neuroscientists and market researchers that they are able to target products and services to consumers based on detection of brain activity. His work has been translated into Chinese, Dutch, French, Greek, Japanese, Portuguese, Spanish and Turkish. In 2008 he was named winner of the J. D. Bernal Prize by the Society for Social Studies of Science (4S).

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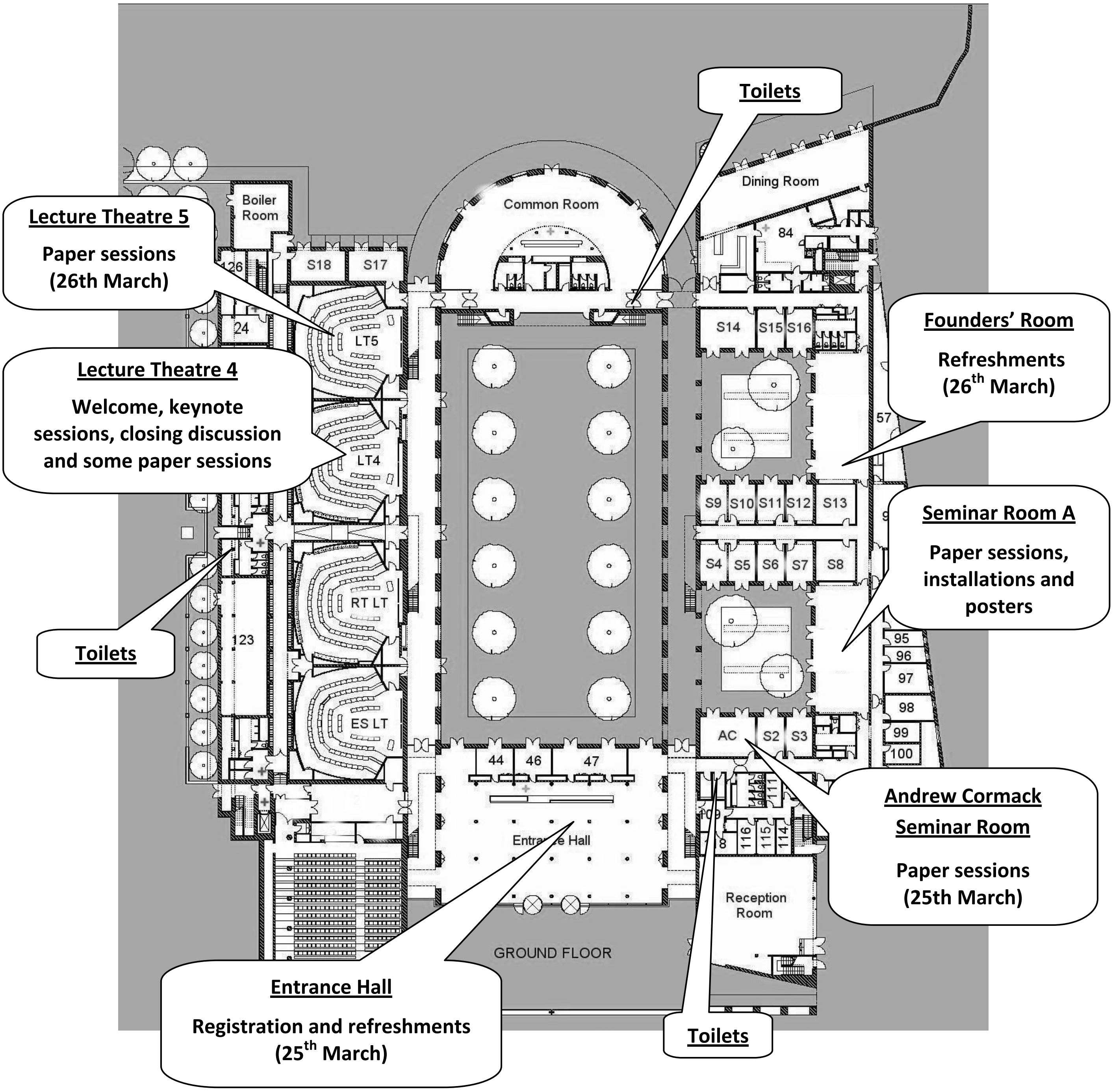
Floor plan Saïd Business School



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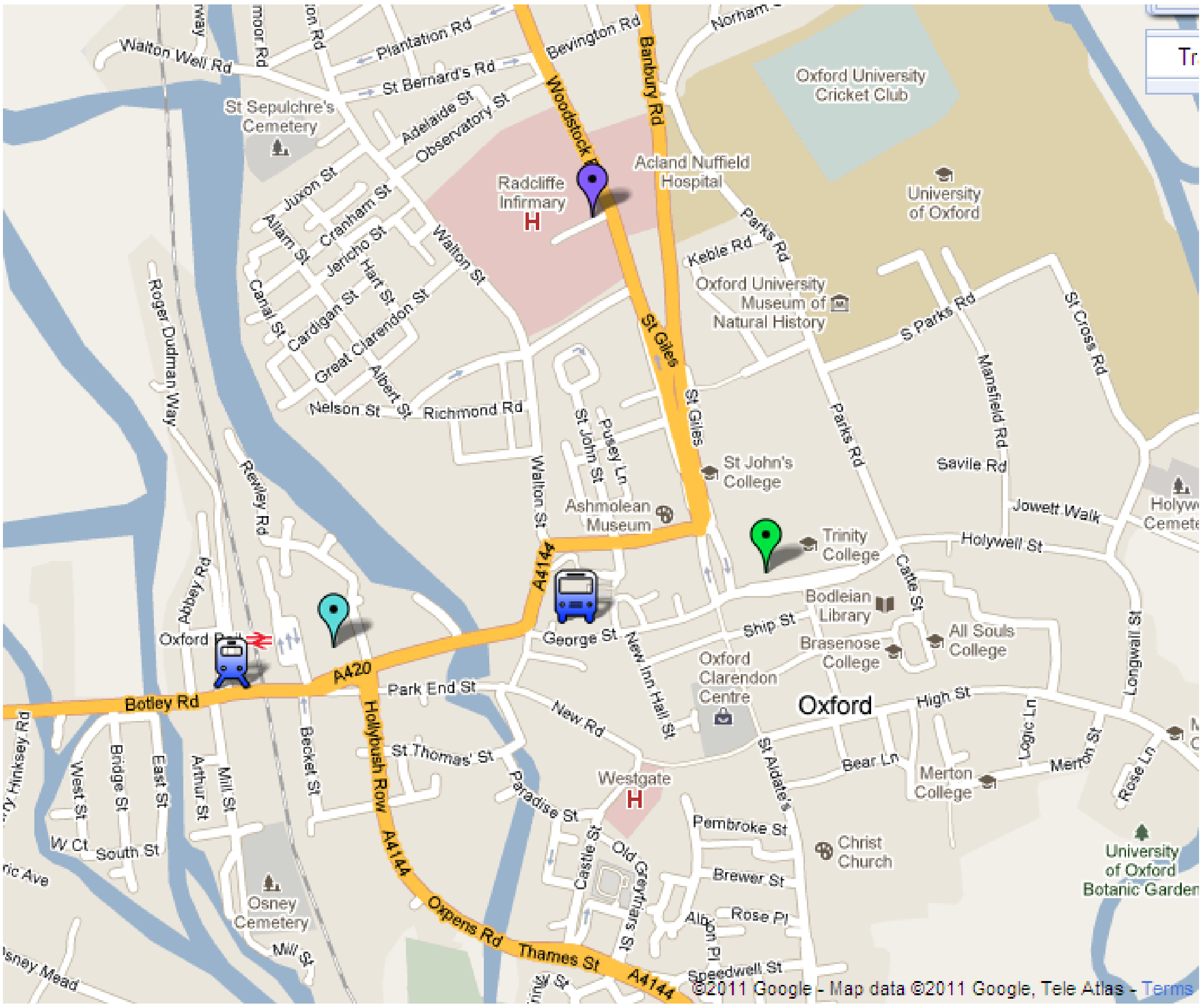
Oxford map



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Balliol College - Accommodation
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jacqueline.fossey@balliol.ox.ac.uk

Green Templeton College - Dinner on 25 March, 7.30pm
Woodstock Road Oxford OX2 6HG

Access to the internet (WiFi)

Delegates registered for the event may use the conference wireless network to access the Internet from the ground floor of the business school site.

Username: March_2011 *(M - Capital)*

Password: March_2011 *(M – Capital)*

Connecting to the service:

Make sure your device is associated to the “SBS-CONF” wireless network; no special configuration is required. Open a web browser and attempt to view a page on the Internet. You will be directed to a secure login site and then asked for the above credentials. By accessing this service you are accepting the terms and conditions that are laid out below.

After login:

This service will be unencrypted. We strongly recommend that you only use secure protocols when transmitting private information. Establish a secure VPN connection to your home institution, if one is available. Many email clients are not configured to use secure protocols. Be especially careful when sending and receiving email. The University of Oxford will not be held responsible for loss or theft of data as a result of using an unencrypted protocol over this network.

Many email clients are not configured to use secure protocols. Be especially careful when sending and receiving email. **The University of Oxford will not be held responsible for loss or theft of data as a result of using an unencrypted protocol over this network**. Please treat this resource with respect. Do not give the username or password to any other person; notify your host or group organizer immediately if you have lost the account credentials. In particular:

- Users are not permitted to use university IT or network facilities for any unlawful activity
- The University may bar access at any time to computers which appear to cause unreasonable consumption of network resources
- Participation in distributed file-sharing or peer-to-peer networks is not permitted
- You must abide by our full IT regulations at http://www.admin.ox.ac.uk/statutes/regulations/196-052.shtml

Twitter

If you will be tweeting during the conference, we encourage you to use the hashtag **#oxvisual** so that others can follow the conversation.