A Manifesto for Web Science?

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1. INTRODUCTION

A clarion call for a new science of the web has been sounded in the pages of CACM (Hendler et al 2008) and elsewhere in path-breaking papers by Berners-Lee et al (2006a, 2006b). These authors point to a paradox: despite the huge effect that the web has had on computing – not to mention the world – computer scientists rarely study the web as a subject in its own right. Web Science aims to redress this: to build a platform where the web can be '… studied and understood as a phenomenon and also something to be engineered for future growth and capabilities' (Hendler et al 2008; 63).

From the outset, web science has been envisaged as a necessarily interdisciplinary endeavour. Whilst it has perhaps always been clear how computer science and maths, in particular, might be harnessed for web science these papers also strongly argued that understanding the web requires knowledge and expertise from the social and human sciences. In fact, disciplines such as Sociology, Geography, Psychology and Cultural Studies have long standing research interests in the web focussing on questions such as identity (Turkle 1995), community (Smith and Kollock 1999), democracy (Hague and Loader 1999), as well as developing more general claims about the place of the web in our increasingly information-based and globalized society (Giddens 1990; Castells 1996; 1997; 1998; Sassen 2006). However, for all this widespread interest in the web, the questions asked and the knowledge generated have remained largely within their disciplinary silos. Even where green shoots of inter-disciplinarity have appeared, for example for the social and human sciences in the journal *Information, Communication and Society* or in cross disciplinary edited collections (*e.g.* Bell and Kennedy 2000) these rarely breach the embedded binary divide between the natural and engineering sciences on the one hand and the social and human sciences on the other.

The call for Web Science insists that we open up this space. In doing so, a flag has been planted. Hendler, Berners-Lee et al have named this territory for web science and have begun to map it from their vantage point in Computer Science. But – and as they would be the first to acknowledge – this is only one vantage point. Other disciplines will add new perspectives and interpretations. However, it is by no means certain that we will all agree about what we see. For whilst we might all agree that Web Science cannot develop without inter-disciplinarity, we should be clear from the beginning that this is no simple matter. We need to be realistic about what we are getting ourselves into. There will be big challenges in making ourselves understood to each other and developing collaborative understandings will require us to leave the comfort of our disciplinary silos. But, the promise of new forms of knowledge and understanding that are bigger than the sum of our parts are gains worth working for.

In this paper, we explore the affordances of four core concepts, drawn from social theory, and suggest that these might prove fruitful in developing the inter-disciplinary thinking across natural, social and human sciences that will be essential for Web Science to fulfill the aspirations of its originators. We suggest that these concepts might help us to do the inter-disciplinary work that Web Science insists on: to think together about the web. First, we consider the *co-constitution* of technology and society: the ways in which people and the web make each other. Second, we emphasise the importance of *heterogeneous actors* - human and non-human - as these are constituted in the networks that produce the web. Third, we focus on the significance of *performativity*, suggesting that the web is less a thing and more an unfolding, enacted practice, as people interact with HTTP to build 'the web' moment by moment. Lastly, drawing together the insights offered by the first three concepts we suggest that we might conceptualise the web as an *immutable mobile*; that is a temporarily stabilised set of socio-technical relations which – whilst it may appear fixed - is eminently open to revision. However, in turn, these concepts raise some fundamental questions about methodology – how we do our research – and epistemology – what claims to knowledge we can make. These are difficult questions but they are central to an inter-disciplinary endeavour such as this where differences in approach – e.g. between quantitative and qualitative perspectives, positivist and interpretivist philosophies –

might reasonably be expected to come to the fore. Furthermore, we suggest that focussing on these differences might open new opportunities for thinking about the politics of the web, the politics of web-science, and to engage with Berners-Lee's (www.guardian.co.uk/technology/2008/jul/09/web.sirtim) vision of the Web as 'pro-human'.

2. CONCEPTS FOR WEB SCIENCE

In what follows, we outline four key concepts taken from social scientific theory and suggest that these provide a core for inter-disciplinary research and thinking about the web.

2.1 Co-Constitution

The concept of co-constitution insists on the *mutual shaping* of technology and society. Technology shapes society. Society shapes technology. The concept originates in a critique of *technological determinism*. That is, a critique of claims that certain innovations are inevitable because of an underlying logic of science; or that a given technology will produce predictable outcomes. Arising from this critique we have learnt much about the social shaping of technology ranging from studies that focus on the social processes shaping the work of scientists to those that look at the evolution of technologies as they are released 'into the wild'. Most obviously, perhaps, we can trace the impact of decisions about funding and commercialisation (Hegecoe 2004) but the Sociology of Scientific Knowledge (SSK) also shows us the social processes shaping scientific practice in the laboratory, for example in negotiating the indeterminacy of scientific results (Collins 1985) and in securing consensus around their knowledge (Latour 1984). Looking outside the laboratory, studies within Science and Technology Studies (STS) have emphasised the evolution of technologies as they come into use. This approach begins from the premise that 'technologies … gain sense and significance within everyday activities and ordinary experience' (Heath et al 2003: 77). There is, then, likely to be a gap between the 'script' embedded within a given innovation – which pre-supposes particular actions and outcomes – and the more complex practices that constitute everyday activities (Ackrich 1992). The school of thought known as the Social Construction of Technology (SCOT) emphasises that as technologies are brought into the field of practice, users exercise 'interpretive flexibility' (Pinch and Bijker 1989), for example ignoring particular functionalities, or developing alternative uses, and produce outcomes that may differ significantly from the original intentions for a given innovation. However, whilst we can learn a great deal from these studies, it is critical that we do not over-emphasise the social at the expense of the technical. The concept of co-construction must also operate in opposition to the notion of *social determinism*. As Mackenzie and Wacjman (1999) insist '[t]he technological, instead of being a sphere separate from society, is part of what makes society possible – in other words it is constitutive of society' (p.23). Rather than privileging the social or the technical 'the links that concern us are necessarily both technical and social (Ackrich 1992; 206: our emphasis). The point of co-constitution, then, is to look at how technology *and* society shape each other. In web science this means we must examine how the web impacts on what people do *and* how people impact on what the web becomes.

2.2 Heterogeneous Networks

The concept of heterogeneous networks was developed with Actor Network Theory (ANT) to explore these interactions and in direct response to the concerns about social determinism described above. ANT is closely related to the theoretical approaches of SSK, STS and SCOT but differs significantly in its insistence on attending to both human and non-human actors (e.g. artefacts, technologies and machines). ANT does not make any a priori distinctions between different kinds of actors but begins from a principle of radical symmetry between humans and non-humans. It proposes that what is important is the ways in which these actors come together in networks to produce particular outcomes. ANT insists that we cannot conceive of a social world independent from the material world. As Latour (1991) argues:

'We are never faced with objects or social relations. We are faced with chains which are associations of humans … and non-humans' (p. 110)

To put this in more practical terms – the actors implicated in the web are the servers, fibre optic cables, the disposable incomes that enable people to invest in personal computers, Tim Berners-Lee, electricity, browsers, global corporations, international standards agencies, the education systems that mean people can use keyboards, read and write, and so on: '*…none of these ingredients can be placed in a hierarchy or distinguished according to its nature*' (Callon 1989; 86). To paraphrase Callon, the bureaucrat in the standards agency is just as important as the servers at Google or HTTP.

Indeed, ANT suggests that actors – human and non-human – are *constituted* by their networks with each other. This is a relational ontology whereby no entity has existence independent of its relations with other entities but comes into being through its relations with others. From this perspective 'the primary epistemological unit is not independent objects [or entities] with inherent boundaries and properties, but rather phenomena' where the concept of 'phenomena' indicates inseparable interacting 'components' (Barad 2003; 815). From this perspective, 'the web' ceases to be something technical – asocial or independent from its use – and becomes a combination (or multiple combinations) of human and non-human actors interacting in networks to produce particular outcomes.

2.3 Performativity

Both the previous concepts share an emphasis on the *doing* of socio-technical relations. If we want to understand the web it is not a case of starting with pre-conceived ideas about what the web 'is' or what society 'is' but looking at what socio-technical relations become as they are performed in everyday life. Taken from Judith Butler (1990) the concept of 'performativity' can be used to capture this understanding. This may seem odd, since Butler is not concerned with technology or the web, rather with the questions of identity, but her argument – and more particularly the general impact that it has had on social theory – is highly relevant. Specifically, Butler inverts the idea that we have identities through which we make choices about how to live claiming, instead, that it is how we live our lives that shapes who we become, and continue to become. Identity is not the performance of an inner core, but rather our identities are produced performatively, by what we do. This may seem a long way from Web Science! But our point is this: the web does not exist as something separate from its doing. Whilst we could – if we chose – model the web in abstract terms, independent from any use of its architecture and protocols, that would not tell us much about what the web is. Apparatuses – such as the technical architecture of the web – do not sit around as finished technologies waiting for use but are 'constituted through particular practices that are perpetually open to rearrangements, re-articulations and other re-workings' (Barad 2003; 816-7). Or to put it another way, this is the difference between seeing the web as a noun – a static, finished and complete object – and the web as a verb – something that is produced in the doing of heterogeneous networks in everyday life.

2.4 Immutable Mobiles

It follows from this that the web is not finished or fixed. Indeed, particular socio-technical networks persist in so much as they continue to be enacted, or performed in repetitive ways. Networks are held together by repetition of the practices that produce them. Furthermore, because there is nothing essential that pre-exists the network, it is only in performance of the network that particular entities are produced and – perhaps – reproduced. If the network changes shape, then the entities that are produced within it will also change. A technological object – for instance the web as we know it - remains stable only as long as the relations between it and its neighbouring entities hold steady (Law, 2000). If new actors join the network, other actors leave or actors behave differently then the entities in the network will be subject to change and the outcomes produced by the network will change.

However, this is not to say that there is no stability, rather that stability is contingent. Networks may be stable if they are repeatedly performed in consistent ways. Indeed, networks may come to *seem* fixed, if they persist such that the relations that produce particular outcomes are 'black boxed' – becoming difficult to disentangle or 'see' as we become used to regular outcomes. In this way, entities – the web for example - may come to be reified – given black box status – but this must not allow us forget the networks that continue to produce that status quo – '… the myriad, daily negotiations among human and non-humans that make up the consensus called technology' (Haraway 1997) or, we would say that make up the web – without which the black box would – once again – be blown apart. The web that we have in this moment is a temporarily stabilised network –for now – but as Law and Singleton (2003) remind us ' …[n]othing is fixed and for ever … Only some things are fixed, and for a time' (p.4-5). To capture this sense of contingent stability Latour introduces the concept of the 'immutable mobile' – to refer to an entity that remains stable over space and time. We can understand the web as just such an immutable mobile, that is a temporary stabilisation of the networks of HTTP, developers, Facebook friends, hackers and governments and schoolchildren and so on. The reification 'trick' is that we 'see' the WWW and not the networks that work to hold its shape.

3. METHODOLOGICAL AND EPISTEMOLOGICAL CONSEQUENCES

Whilst these concepts may offer promising ways of thinking about the on-going socio-technical production of the web, they also raise some fundamental methodological and epistemological questions for Web Science as an interdisciplinary project. How can we do research that takes these concepts seriously and what are the consequences for the kind of knowledge that we can claim to produce?

The immediate implication of these concepts it that we need to follow the actors, to see what human and non-human actors do: to '… try to catch up with their often wild innovations in order to learn from them what the collective existence has become in their hands' (Latour 2005; 12). Clearly, we need to work together across disciplines to harness our diverse expertise if we are to follow these heterogeneous actors. But we also need to think about the methodologies (the rationale and philosophy) and methods (techniques and procedures) that we use to do this.

Traditionally the natural sciences have been associated with positivism, an approach that sees science as necessarily objective and value free, and is rooted in deductive methods which seek observable evidence on which to base predictive laws. This view of science was heavily critiqued from the social sciences and humanities which argued – as we have seen above – that science was socially constructed, and emphasised the importance of subjective understanding. These well worn debates - popularly encapsulated in the term the 'Science Wars' do not need to be rehearsed here (although minor skirmishes continue c.f. Stephen Hawking's take on positivism). But

they are important in so far as they opened up the opportunity for different accounts and models of science such that, for the most part, social science now recognises a range of methodological approaches and embraces a multiplicity of qualitative and quantitative methods. These include both positivist inspired research which relies on controlled experiments and statistical methods through to more interpretivist approaches which typically employ face to face interviews or observation of 'naturally' occurring (i.e. non-experimental) situations to get at people's own meanings and understandings.

We suggest that, if we are to follow the all actors implicated in the web we need to adopt both inter-disciplinarity and mixed methods and open up web science to the ontological, epistemological and methodological possibilities offered by the social sciences and humanities. This will move web science (and many of its current proponents) outside the comfort zone of positivist science. It will mean critically engaging with alternative epistemologies and ontologies that propose multiple realities, with critical and participatory approaches which place subjective experience at their core, and methodological debates that question the very nature of 'scientific' validity and reliability.

This is new territory and we must recognise that this will not be easy. However it is worth noting that other disciplines have charted similar terrain reasonably successfully. For example the application of sociology to medicine – and the creation of the sub discipline of medical sociology) - has involved a critique of largely positivist biomedicine in order to comprehend the important social interactions of health care and services. Whilst positivism – and its most favoured method the randomised controlled trial - has proved invaluable for testing the efficacy of medicines, the complexities of patient care, professional-patient interactions and health care organisation have had to be tackled with a far wider range of methods – methods designed to uncover what people think and what they do. The challenge facing web science will be whether it can let go of the kind of scientism that imagines a universal theory or 'laws' of the web, and instead grasps new ways of knowing. Rather than privileging quantitative or qualitative approaches, multiple methods can be used to capture different aspects of the web and offer different insights to the same aspects of the web. This acts as a corrective to analytic tunnel vision, offering rigour without rigidity from which we can create greater analytic density (Fielding 2009): it stops us trying to force incompatible concepts and perspectives into a coherent theory where all the ends tie together and opens spaces for dialogue between diverse perspectives that can enhance our understanding.

4. THINKING ABOUT THE WEB CRITICALLY

We suggest that the kind of trans-disciplinary spaces that we are endeavouring to open up make a central contribution to our critical understanding of the web. For a start, we can say with confidence that the web is not outside of society, but co-constituted with it in heterogeneous networks that are *both* challenging and re-producing older forms of inequality *and* producing their own varieties of inequality. Whilst some actors are excluded – the illiterate, the poorest, and so on – others acquire new forms of power – global media corporations, and 'geeks bearing gifts' or those with particular technical competencies. At a finer level of granularity, amongst those who are connected, some can make expert use and derive enormous benefits, whilst others cannot (Hargittai 2008), producing new forms of power and inequality inside the web. From this perspective, we cannot see the web as, somehow, outside of power relations or as a simple solution to inequality. There may be enormous benefits from enabling access to the web, via hardware and education, but we should not assume that this is a simple answer to inequality or will produce predictable outcomes.

Nonetheless, as web scientists we are – potentially – in a unique position to use our insights to offer interventions that might foster change for a better world. Indeed, from the start the proponents of web science have promoted a vision of the web as 'pro-human' (Berners-Lee et al 2006a) but this has been narrowly interpreted as re-engineering the web to make it 'work better'. By breaking away from positivist paradigms, and opening up diverse methodological and epistemological approaches the opportunities for intervention are far greater: we can ask critical questions about what we know and how we can know it, we can articulate voices, experiences and perspectives silenced in quantitative and positivist paradigms and question hegemonic assumptions about what counts and how. In this respect, web science could learn other traditions in the academy, from political philosophy, feminist theory and critical race theory which have shown so well how the narrow methodological and epistemological foundations of modernist science that validate themselves through appeal to objectivity and rationality can work to replicate entrenched power relations and inequalities. Again these critical perspectives may not be comfortable or easy, but as Haraway argues:

'The point is to make a difference in the world, to cast our lot for some ways of life and not others. To do that one must be in the action, be finite and dirty, not transcendent and clean.' (Haraway 1997; 36)

A web science that takes up the challenge to be genuinely pro-human must, we contend, make a commitment to recognising inequalities and the potential for things to be otherwise.

5. A MANIFESTO FOR WEB SCIENCE

The perspectives that we have outlined above are drawn from social science, but we suggest that they might offer an inclusive platform for web science. The point is not to replace the earlier map drawn by Berners-Lee et al but to broaden the territory that it covers and fill in some of the detail. We would hope that the contribution of the social sciences and humanities will be recognised as an important element in the foundation of web science. In summary then, we propose a manifesto for web science – suggested in the spirit of stimulating further debate and discussion – as follows:

1: Web Science must be the genuine intersection of discipline; i.e. it cannot be allowed to be a sociology or a computer science of the web;

2: Web Science must look both ways to see how the web is made by humans and how humans are made by the web;

3: Web Science must follow all the actors (individual, groups and technologies) and trace the networks implicated in the web in the broadest sense and understand the effects of these networks;

4: Web Science must move beyond narrow epistemologies and methodologies to enable a science which can examine and explain both micro and macro phenomena;

5. Web Science must be a critical discipline - if it is to speak to the desire for the web to be pro-human – it must develop theoretical thinking and push towards critical, political social theory, to critique the direction of travel, to challenge the web and society.

We offer this manifesto as the a framework for a genuinely interdisciplinary and critical endeavour, one that will draw on the widest range of methods necessary to understand, inform and challenge the web and society and ensure that web science is truly greater than the sum of its parts.

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