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Toward an Analytical and Methodological Understanding of Actor-Network Theory

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ABSTRACT

Actor-Network theory (ANT) is well developed within social studies of science and technology. The last two decades have seen an increasing awareness and interest in ANT within the social sciences and it has increasingly been invoked to theorise the role of 'nonhumans' in social life. In this respect the conceptual repertoire of ANT has been increasingly drawn upon to examine the relational dimensions between artefacts and people. Despite this the use of ANT as an analytical and/or methodological approach occupies a peripheral within social science research. In part, the reticence towards ANT may be explained by its lack of theoretical unity. Analytically and methodologically the application of ANT and thought which is closely associated with the approach is considerably varied. ANT informed research often differs quite considerably in terms of methodological approach and style of analyses. This is further complicated by the disparate emphases of ANT proponents and the proliferation of different versions of ANT. Thus, there is no generic way to 'apply' actor-network theory and it lacks methodological prescription. This article intends to articulate the analytical and methodological possibilities of ANT. For those who are encountering ANT for the first time or for whom ANT has been regarded as a somewhat left field and inaccessible theory obscured by its own vocabularies and heterogeneity this article may provide a useful conceptual map through which the key elements of ANT can be navigated.

Key words: Actants, actor-network theory, methodology, nonhuman, quasi-objects, translation.
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1.0 Introduction

Actor-network theory (ANT) is well developed within social studies of science and technology, and as (Law, 1999:10) pronounces, 'has spread'. The last two decades have seen an increasing awareness and interest in ANT within the social sciences and as (Nimmo, 2011:108) points out, 'has increasingly come to be seen as an important reference point for anyone who wants to take seriously the role of 'nonhumans' in social life.' In this respect the conceptual repertoire of ANT has been increasingly drawn on to theorise the relational dimensions between artefacts (most often technology) and people (Cordella & Shaikh, 2006). Despite this the use of ANT as an analytical and/or methodological approach remains [as yet] a peripheral move within social science research. In part, the reticence towards ANT may be explained by its lack of theoretical unity. Analytically and methodologically the application of ANT and thought which is closely associated with the approach is considerably varied. McLean & Hassard (2004:496) make this point when they state that we should note that, 'the research produced often differs markedly in terms of methodological approach and style of analyses. Thus, there is no generic way to 'apply' actor-network theory and it lacks methodological prescription. This is further complicated by the disparate emphases of ANT's proponents (Michael, 1996) and the proliferation of different versions of ANT.

There are, however, some key elements to the approach that remain relatively stable (Walsham, 1997) and which can be summarised thus:

Table 1. Summary of key concepts of actor-network theory[2].

Actor / actant	Any material, i.e. human beings or nonhuman actors / actants.
Actor-network	Related actors in a heterogeneous network of aligned interests.
General symmetry	The symmetrical treatment of humans and nonhumans as *a priori* equal.
Translation	How actors generate ordering effects by negotiating or manoeuvring others' interests to one's own with the aim of mobilising support.
Inscription	Embodied translations into a medium or material.
Enrolment	Mobilise support by creating a body of allies through translation.
Black box and punctualisation	A temporary simplification in a network that acts as a single unit so that the network effaces into one actor.
Quasi-object	A nonhuman that is necessary for the collective to exist; An object that passes through a social group which in doing so forms relations between members of that group.
Hybridity	The idea that neither a human nor a nonhuman is pure, that is, either human or nonhuman in an absolute sense but rather entities produced in associations between the former and the latter. Thus, humans are considered as quasi-subjects and nonhumans as quasi-objects.

These elements represent the foundation concepts of an analytical and methodological approach for ANT. Individually or together they provide a mechanism through which researchers can extend their study of the social to include nonhumans and open up their gaze to examine the interrelations between humans and nonhumans (Nimmo, 2011).

There is however a paucity of work that has sought either to articulate these elements of ANT and / or clarify the analytical and methodological possibilities of ANT. For this reason ANT's potentialities have remained somewhat hidden in its theoretical diversity and the confusion this presents in how to 'do' ANT. Whilst this article does not claim to provide a way to 'do' ANT – I believe ANT will remain eternally elusive in this regard – it does attempt to decouple ANT's key elements from ANT's esoteric and profanely abstract writings to provide a more synthesised expose of these elements. In doing so, this article intends to articulate the analytical and methodological possibilities of ANT. For those who are

[2] This table is adapted in part from (Walsham, 1997). Here it has been modified and extended.

encountering ANT for the first time or for whom ANT has been regarded as a somewhat left field and inaccessible theory obscured by its own vocabularies and heterogeneity this article may provide a useful conceptual map through which the key elements of ANT can be navigated.

2.0 Key elements of ANT: Actants, actor-networks, translation and quasi-objects

As a paradigm that has emerged over the last two decades or so, actor-network theory has its roots in the work of (Callon, 1986a & 1991) and (Latour, 1987, 1992 & 1993) and their studies of 'science in action'. Latour (1987) demonstrated that the capacity of scientists to generate knowledge or truths was dependent and rested upon their abilities to align an array of discordant or heterogeneous elements or allies inside and outside of their laboratories. Michael (1996:52) describes the various forms that these allies might take:

> 'These allies might belong to what we would normally count as 'the world of science' – for example, experimental materials and equipment. Alternatively (or complimentarily), they might reside beyond its borders – for example, consumers, funders, public supporters and the like.'

This reveals a picture of the agency of scientists as dependent upon associations with other heterogeneous elements, rather than independent and located within the self. Lee (2001:129) considers (Latour's, 1988a) exposé of Louis Pasteur to be the most distinct example of an ANT approach to agency. In discussing this, (Lee, 2001) draws out that, (Latour, 1988a) in re-writing the history of one of France's greatest scientists illustrates how Pasteur's achievement and his work was not the sole result of Pasteur's cognitive capacities as a genius nor the exclusive product of social cognition. Rather, (Latour, 1988a) demonstrates that it was the result of a series of relations between heterogeneous elements – both human and nonhuman. Thus, he exposes, through careful analysis, how it was that Pasteur's work was dependent upon the 'Pasteur network' which consisted of 'laboratories, domesticated strains of bacteria, notebooks, statistics…the journalists who witnessed Pasteur's spectacular experiment…the French electors Pasteur sought to convince' (Callon & Law, 1997:169) and so on.

In *The Pasteurisation of France*, Latour wished to illustrate and understand the networks of associations and forces among actors. His explanatory method was to make no *a priori* distinctions among the various allies involved in these networks of association. In this approach, Latour dissolved the methodological distinction between humans and nonhumans, in so far, as only the former are usually considered to be actors. Invoking the neologism 'actant' in order to emphasise the 'indeterminacy of the actor', (Callon, 1999:181) to (Latour, 1997), an actor [actant] is:

> '…something that acts or to which activity is granted by others. It implies no motivation of human individual actors nor of humans in general. An actant can literally be anything provided it is granted to be the source of an action'.

Thus, actors are simply considered as any entity that *does* things. In the 'Pasteur network', for instance, microbes are not inert, they cause unsterilised material to ferment whilst leaving sterilised material untouched. If they had acted otherwise, that is, if they did not collaborate with Pasteur – if they did not act (at least in the way Pasteur intended) - then the story of Pasteur might have been somewhat different. It is in this sense that Latour can speak of the microbes as actors.

The Pasteur story serves to introduce some of the key (interrelated) elements of actor-network theory. First, in revealing Pasteur's agency as dependent upon the network of associations created between humans and nonhumans, it provides a method of opening up agency to empirical enquiry (Lee, 2001:130-131). Second, it introduces the idea of 'heterogeneous networks', that is, the 'patterned networks of diverse (not simply human) materials' (Law, 1992) and the notion that effects such as agency are collectively generated in these networks. Third, and relatedly, in Latour's treatment of the

human and nonhuman as *a priori* equal, the principle of 'general symmetry' is given voice and allows for the scope of analysis to be extended to include the role that nonhuman actors or actants play in the creation of heterogeneous networks and the effects these networks produce.

However, as (Law, 1992) has suggested:

> '…the task of sociology is to characterise these networks in their heterogeneity, and explore how it is that they come to generate effects…'

How then are sociologists / actor-network theorists to go about this process of characterising networks and understanding how it is, for example, that an individual such as Pasteur can appear as a single point actor? One methodological strategy is what (Callon, 1986a) and (Latour, 1987) refer to as *translation* which serves as a heuristic device to conceptualise the process of how networks are assembled and therefore how effects come to be generated. This strategy is exemplified in (Callon's, 1986a) case study *Some Elements in a Sociology of Translation: Domestification of the Scallops and Fishermen of St. Brieuc Bay*, in which Callon gives an account of the attempts of three marine biologists to convince a group of fishermen (and also scallops) of the advantages to be gained in the use of scientific knowledge to increase scallop numbers. Here, Callon explores through what he calls the *process of translation,* the complex endeavours of these scientists to construct a 'scientific network' by persuading, in exactly the same manner, both humans and importantly, nonhumans to comply with them (Murdoch, 1997).

The *process of translation* as described by (Callon, 1986a) in the aforementioned case study involves a number of overlapping stages or dimensions: *problematisation*, *interessement, enrolment and mobilisation.* Drawing directly on (Callon, 1986a:196-224), these 'four moments of translation' (1986a:196) are described below in conjunction with a more anecdotal description of the translation attempts of the marine biologists at St. Brieuc Bay.

Table 2. Stages of the Process of Translation in the Domestification of the Scallops and Fishermen of St. Brieuc Bay.

Stage	Definition of stage	Description of stage or what happens
Problematisation	The researchers sought to become indispensable to other actors in the drama by defining the nature and the problems of the latter and then suggesting that these would be resolved if the actors negotiated the 'obligatory passage point' of the researchers' programme of investigation.	Fishermen: You are fishermen and we are marine biologists. You need to ensure adequate stocks of scallops and we have the solution to this. Scientific colleagues: You are interested in advancing knowledge about scallops. Scallops: You are being dredged from the sea. We can give you a shelter that will enable you to multiply and survive.
Interessement	A series of processes by which the researchers sought to lock the other actors into the roles that had been proposed for them in that programme.	Fishermen: Here is a towline. It protects scallops from predators, from dangerous currents and from dredges that injure them. They will be able to proliferate without any threat. Scallops: Here are collectors. You can anchor and grow without any threat. Scientific colleagues: There is a lack of knowledge about scallops. Their population is declining. Here is our evidence. It is important that we ensure their survival as a matter of economic necessity.

Enrolment	A set of strategies in which the researchers sought to define and interrelate the various roles they had allocated to others.	Fishermen: No strategies needed they are content to accept the role envisioned for them by the researchers. Scallops: Strategies to convince scallops to anchor – physical violence against predators; alterations to interessement devices; consent without discussion. Scientific colleagues: Discussion of results and acceptance of previous evidence about scallop anchorage.
Mobilisation	A set of methods used by the researchers to ensure that supposed spokesmen for various relevant collectivities were properly able to represent those collectivities and not betrayed by the latter.	Fishermen: A few fishermen speak for all fishermen. Scallops: A few anchored scallops speak for all unanchored scallops. Scientific colleagues: a few specialists speak for all specialists. Researchers: Displace scallops and fishermen from their home to a conference room, although the scallops have been transformed into a series of equations and diagrams. Enrolment is transformed into active support from fishermen and scientific colleagues – the former who want scallop numbers to increase and colleagues who consider the results valid and presumably scallops too considering that some have anchored and offered their support. At the end of the process the marine biologists speak for all.

In his analysis of the events that surrounded St. Brieuc Bay, (Callon, 1986a) illustrates the process of translation, that is, the building of an actor-network from human and nonhuman entities. In addition to this, he concurrently demonstrates how a particular agent (like Pasteur) or a group of agents (like the marine biologists) come to speak for all the other actors (both human and nonhuman) in the network. However, (Callon, 1986a) also demonstrates that the durability of the actor-network is dependent upon the robustness of its weakest links. For example, if one of the actors refuses to remain fixed in place then the network can breakdown (Akrich, 1992 & Latour, 1987). This is more or less what followed in the 'scientific network' of the marine biologists at St. Brieuc Bay in (Callon's, 1986a:219-224) discussion of *dissidence.* When the experiment was repeated the scallops refused to anchor and the fishermen committed mutiny by harvesting the protected scallops of the first anchorage. In doing so, the scallops of the first anchorage were betrayed by all the other scallops they were supposed to represent and the representatives of the fishermen (who agreed not to fish the protected scallops) were betrayed by the fishermen they were representing (Michael, 1996). Here, (Callon, 1986a:220) asks if anchorage was in fact the obligatory passage point all along and not, as was previously assumed, the marine biologists. Moreover, the support of the scientific colleagues of the marine biologists began to waver. In sum, the actor-network collapsed.

The process of translation gives an explanation as to how potential or would be actors (like the marine biologists) attempt to establish themselves as actors by building an actor-network from various entities – a process which (John Law, 1987) has called 'heterogeneous engineering'. Put simply, translation:

> '…builds an actor-world from entities. It attaches characteristics to them and establishes more or less stable relationships between them. Translation is a definition of roles, a distribution of roles and the delineation of a scenario. It speaks for others but in its own language. It is an initial definition' (Callon, 1986b:25-26).

However, (Callon, 1986b) reminds us that this process of defining and distributing roles is subject to resistance:

> 'But…no translation can be taken for granted for it does not occur without resistance…Successful translation depends upon the capacity of the actor-world to define and enrol entities which might challenge these definitions and enrolments' (Callon, 1986b:25-26).

That is to say, the roles that are defined and distributed to the various entities within the actor-network may be challenged, resisted, undermined or destroyed. The heterogeneous nature of actor-networks means that any entity can refuse their role within the network or betray the role assigned. When this happens a general process of retranslation can occur or the actor-network may disintegrate (Michael, 1996). Callon (1986:224) points out that being able to describe the ways in which actors come (or do not come) to accept particular roles and identities in actor-networks is a method through which an understanding of 'what sociologists generally call power relationships' can be understood. In discussing this Michael (1996:53) states, for example, that:

> '…enrolment is not a unilateral process of imposition: it entails both the 'capturing' of the other and the others 'yielding'. It is a multilateral process'.

The argument is that the operation of power can be followed by analysing the methods and stratagems used and deployed by enrolling actors to secure the conformity of target actors and the negotiations that may take place between these actors during this process (Law and Callon, 1992). For example, in order to enrol the fishermen at St. Brieuc Bay, the marine biologists had to present their question about scallop anchorage in terms of the fishermen's need to have access to adequate levels of scallop stocks. This involved having to suppress the short-term interests of fishermen (harvesting as many scallops of possible) and persuading them instead to consider their long-term interests (durable scallop stocks). Therefore, the conformity of the fishermen was ensured through the manipulation and control of their interests, thoughts and desires. However, as (Michael, 1996:57) points out, the 'power' of the marine biologists was dependent upon the continuing consent of the fishermen and their adherence to this point of view. When the fishermen unashamedly harvested the protected scallop beds of the experiment, the 'power' of the marine biologists or rather as he highlights 'their relation of power to the fishermen' was broken. Furthermore, a similar scenario developed when the scallops refused to anchor. Therefore, the relations of power between the marine biologists, the fishermen and the scallops were desecrated.

In this case study the marine biologists fell from their position of power. However, whilst translation allows for the microsociological study of the mechanics involved in the ways that particular agents may gain (or lose) and extend (or fail to extend) influence, the view of power that is emphasised is one in which power is considered to be *relational* in so far, as actors gain their powers through the sets of relations they construct with other actors and therefore are an *effect* or *outcome* of these sets of relations (Law, 1991). Thus, rather than subscribing to, for example, a traditional view in which power is considered as being the possession of agent, that is, as something that is located within the self (Fox, 2000), power (like agency) is viewed as something that is distributed between the actors in a network and which arises a result of the collective action of the actor-network. Akin to agency then, an actor-network approach to power excavates what actors are dependent upon for their powers. In doing so, it is argued that the somewhat deceptive impression that power resides within a single actor is displaced:

> 'Power is always the illusion people get when they are obeyed… [they] discover what their power is really made of when they start to lose it…it was made of the wills of all the others…power [is] a consequence and not a cause of collective action' (Latour, 1986:268-9).

Thus, for the marine biologists of St. Brieuc Bay, their dependence upon, for example, the wills of fishermen and scallops for their powers may have become apparent only when their respective

betrayals dissipated these powers.

Here, actor-network theory is close to Foucault in so far as there is a shared concern with the constructed nature of power (and agency) (Michael, 1996), for example, as (Foucault, 1986: 234 cited in Michael, 1996) states:

> 'The individual is not to be conceived as a sort of elementary nucleus, a primitive atom, a multiple and inert material on which power comes to fasten or against which it happens to strike, and in so doing subdues or crushes individuals. In fact, it is already one of the prime effects of power that certain bodies, certain gestures, certain discourses, certain desires come to be identified and constituted as individuals.'

Thus far, my discussion has progressed from a concern with agency into a concern with power and back again. This is because, as (Michael, 1986:63) suggests, these are issues which are interrelated and as has been illustrated here, 'agency is like power – a product and an effect' of networks of heterogeneous relations. However, the concept of heterogeneous networks is considered by actor-network theorists to be applicable to 'all of social life' (Law, 1992). Therefore, as (Law, 1992) suggests:

> '…the family, the organisation, computing systems, the economy and technologies…all of these are ordered networks of heterogeneous materials whose resistance has been overcome.'

According to (Law, 1992), what is radical about this is the claim that nonhumans are crucial participants in these heterogeneous networks and, therefore, in our social relations. Discussing the materiality of the social world, (Law's, 1992) claim is 'that almost all of our interactions with other people are mediated through objects of one kind or another' (cf. Dant, 1999 for a similar non actor-network argument). Similarly, (Latour, 1986) has suggested that the social is held together by things, or more precisely, in relations between heterogeneous actors. The argument is that human interaction alone cannot hold social relations in place.

In order to demonstrate this (Latour, 1994a, 1994b cited in Murdoch, 1997) has provided a genealogy of the development of human society which emphasises the increasingly complex nature of configurations between humans and nonhumans. According to (Murdoch, 1997), (Latour's, 1994a, 1994b) suggestion is that as human society has developed, so too have associations between the human and the material. Latour begins with a vision of humans akin to simians and moves through a discussion of primordial society, agrarian society, industrialisation and concludes with a debate about contemporary environmental crises.

In the beginning, he argues, that humans are essentially like baboons living in a society which is solely dependent upon interactions between humans. He suggests that humans are constantly involved in negotiating and renegotiating their social order because nothing can last longer than the interactions themselves. In this stage, social order is never stable or enduring but in a constant state of flux. However, humans progress and in so doing, they begin to associate with material allies. To begin with these material allies are the simple tools of primordial man but in moving towards an agrarian society wherein farming techniques bring in a range of natural (animals and plants) others associations become increasingly more prolific, diverse and complex. This continues with the advent of industrialisation where another layer of material associations is added (machines and so on) and terminates with the nonhuman actors of the natural world which enter into society 'as active participants, reconfiguring societies' (Murdoch, 1997:328).

Latour's thesis is that the development of increasing associations between humans and nonhumans results in removing humans further and further away from pure interaction (human only interaction). In increasing associations with nonhumans he argues, that a stable and enduring social order is built up in which relations are held in place by material objects.

Latour (1994a, 1994b) takes this argument much further in order to demonstrate how it can be applied to overcoming sociology's dualisms, for example, macro/micro, agency/structure and so on, however, here the point of analytical interest lies with the proposition that material objects participate in and hold relations in place. Bending this point somewhat (although not completely), I wish to draw into the discussion (Michel Serres', 1982) concept of the quasi-object. Simply stated, and reiterating the definition previously given above, a quasi-object may be defined as: a nonhuman that is necessary for the collective to exist; or 'an object that passes through a social group which in doing so forms relations between members of that group' (Carr & Downs, 2004:357). These are 'special' objects, in so far, as human relations are considered to emerge from their circulation within social groups, that is, they are 'weavers of collectivities' (Brown and Lightfoot 1999).

In *Angels: A Modern Myth* (1995:47-48) the concept of the quasi-object as a weaver of collectives is given when Serres' character Pia states:

> 'Look at these children out there, playing ball. The clumsy ones are playing with the ball as if it were an object, while the more skilful ones handle it as if it were playing with them: they move and change position according to how the ball moves and bounces. As we see it, the ball is being manipulated by human subjects; this is a mistake – the ball is creating the relationships between them. It is in following its trajectory that their team is created, know itself and represents itself. Yes the ball is active. It is the ball that is playing.'

Serres' (1982) argument is that it is the ball – the quasi-object - that creates relations as it circulates and moves within the collective. Moreover, the subject, for example, the ball player, is defined by their relationship to the ball:

> 'The subject is decentred because relations among subjects arise with the quasi-object and not, for example, by means of the Cartesian 'I'' (Carr & Downs, 2004:357).

Thus, for Serres quasi-objects are the source of relations within collectives and creators of subjects.

Serres, suggests that objects, in particular those which circulate amongst groups of people, are implicated in and structure human relations. Although, never using the term 'quasi-object' or referring to Serres at any point, (Valentine, 2002) in an actor-network account of food in the workplace illustrates how food and drink as nonhuman entities construct, maintain and stabilise relations between humans. She talks of assemblages between people and food; for example, in her account food and drink stuffs emerge at times as quasi-objects that circulate within the workplace binding groups together, ordering and producing their relations. At a more general level Valentine's argument is that there are no workplace relations without participation between humans and nonhumans. The point of argumentation is that social relations are held in place by objects (such as food or drink) that circulate and bind. Thus, it is argued that social scientists need to recognise that humans are not necessarily the 'prime movers' in relations (Valentine, 2002:2, Akrich, 1992).

Serres' thought on quasi-objects (amongst other things) has been influential in the development of actor-network theory. Most crucially, it has paved the way for the description of humans and nonhumans in terms of assemblages and allowed for a consideration of nonhumans as active participants in social life, which has been developed empirically in the works of Callon and Latour (as in the exemplars given above). Speaking of this and of quasi-objects in particular, (Stuart Lee, 2002: 65) in an exposé of thought on 'hybridity' discusses how, for example, Latour is often considered to be the 'primary champion' of quasi-objects', with Serres' influence often being overlooked. However, Latour's sense of the quasi-object is bound up with the notion (and it is a related notion) of permeable boundaries between humans and nonhumans. Prout (2000:14-15) phrases this well in discussing the associations between humans and nonhumans that constitute heterogeneous networks:

> '…so ubiquitous are associations between humans and the rest of the material world that all entities are to be seen as hybrids – what (Latour, 1993) has termed 'quasi-objects' and 'quasi-subjects' – where the boundary between the human and the nonhuman is shifting, negotiated and empirical'.

Thus, Latour's notion of the quasi-object (and quasi-subject) represents, in much the same way as Serres', another analytical tool that facilitates an articulation of the mutually co-constructive relationship between the human and the nonhuman (Lee, 2002), although the empirical task is to examine the processes endemic to this co-construction.

3.0 Points of critique: symmetry, punctualisation, representation, black-boxes and cutting the network

Actor-network theory has not been without its critics and there exists many critical commentaries on the approach. However, for the most part, the criticisms levied towards the approach that are relevant here, tend to oscillate around how actor-network theory treats the human and the nonhuman and who or what is included and excluded in actor-network accounts. Additionally, and somewhat relatedly, is the issue about who and what actor-network theorists can legitimately claim to represent in their works. Below, each of these issues is discussed in turn.

Of all the debates that surround actor-network theory and its analytical repertoire, the symmetrical treatment of humans and nonhumans is possibly the most well known and contentious of these. As (Hassard et al, 1999) cited in (McLean and Hassard, 2004) point out, it is because of the way that actor-network theory brings together humans and nonhumans in the same analytical view that it has gained so much notoriety. However, as (McLean and Hassard, 2004:502) do well to highlight, it should be noted that:

> '…this is not a 'concern' for proponents of actor-network theory, only for those who would call the approach into question'.

However, whilst actor-network theorists may be 'unconcerned' over the issue of the symmetrical treatment of people and things – indeed (Doolin and Lowe, 2002) consider ANTs explanatory power to arise from exactly this stance - given that it occupies a major point of critique, at least among the protagonists, it would be somewhat of a misnomer to gloss over the issue.

For the most part, there are two interrelated points of contention. First, ANT's insistence that humans and nonhumans should be treated as analytically equal and second, that nonhumans should be considered alongside their human counterparts as potential actors. In proposing this, ANT treads upon a set of ontological toes (Law 1992). It does so because it problematises traditional / modernist conceptions that maintain rigid divisions and distinctions between humans and nonhumans (Pels et al., 2002).

This breaking of the conventional boundaries and differences that are considered to exist between humans and nonhumans represents a major point of contention in the debates that surround ANT. Star (1991) draws attention to this point of contention when she highlights that attempts to subvert the moral divisions between humans and nonhumans are considered to be dehumanising ones. Vandenberghe (2002:53) in a [humanist] critique of ANT, for example, offers the following statement on the differential capacities of humans and nonhumans in respect to action:

> 'Do cubes, bricks, slabs, beams, columns and bottles of beer act? Do they co-ordinate their actions through a common definition of the situation? Are they kept together or driven apart from each other through agreements and disagreements? Obviously not. Bottles, beams and

> slabs do not act. Only humans (and animals) act; not endowed with intentionality, artefacts do not act.

This statement is close to the sceptical (Collins and Yearly, 1992:312-316) who in discussing the possibility of (Callon's, 1986a) scallops possessing the ability to act ask: How is it possible to think of a scallop as deciding to attach itself to a collecting net? As far as (Vandenberghe, 2002:53) is concerned humans and nonhumans 'belong to different ontological regions' and constitute quite 'different and incomparable ways of being'. In passing over different ways of being, he continues to argue that actor-network theorists reduce the analysis of human action, meaning and humans to an approach which essentially views humans as:

> '…rational action theorists who behave like 'centres of calculation', strategically associating and dissociating humans and nonhumans alike, pursing their own political ends by economic means…meaningful action disappears and all we are left with is a pasteurised and desymbolised world of strategically acting dehumanised humans, or humants' (Vandenberghe, 2002:55).

On the other hand, some authors have raised concerns over how ANT appears, at times, to grant a higher status to nonhumans vis-à-vis humans (McLean & Hassard, 2004). Collins and Yearly (1992), for example, have argued that actor-network theorists have assigned too much strength and importance to nonhumans and that in doing so they have returned us to technological determinism (McLean & Hassard, 2004). Collins and Yearly (1992:310) object to what they consider to be a misconceived extension of symmetry arguing that 'symmetry between all kinds of actants once more removes humans from the pivotal role'. In discussing Collins and Yearly in their refusal to be drawn into what he refers to as a 'Latourian ontological symmetry', (Pels, 1996:297) has suggested dropping the symmetry principle and replacing it with a notion of 'weak asymmetry, or a weaker notion about the permeable boundary running between humans and nonhumans'. However, as (Doolin and Lowe, 2002) point out diminishing the status of humans is not the task of ANT. Rather, it wishes to consider the role of what (Latour, 1992) refers to as the 'missing masses' (nonhumans) in the heterogeneous networks that characterise the social.

As (Law, 1999 pg. 4) states, 'much ink indeed has been spilled over the importance or otherwise of the distinction between human and nonhuman'. However, for (Law, 1992) criticisms levied towards ANT of the sort mentioned above are somewhat misguided. ANT has never implied an equality of essence between humans and non humans nor has it proposed that nonhumans act with the intentionality that is imbued in human actors or equally that human actors have no intentionality or capacity for intentional action (cf. Pickering, 1993). Rather, its 'theory' of the actor is ambiguous:

> '…ANT is based on no stable theory of the actor; rather it assumes the *radical indeterminacy* of the actor. For example, the actor's size, its psychological make-up, and the motivations behind its actions – none of these are predetermined' (Callon, 1999:181-182).

Thus, no *a priori* essential characteristics are attributed to actors. Law (1992) draws attention to the need to clarify that the symmetry principle is an 'analytical stance, not an ethical position', and that advocates of ANT are not suggesting that humans should be treated like nonhumans or vice versa, but rather that the divisions between them are negotiable, fluid and changing (cf. Woolgar, 1992, Turkle, 1984). Therefore, he argues that it is not that divisions or distinctions are not considered to exist but rather:

> '…such divisions or distinctions are understood as effects or outcomes. They are not given in the order of things' (Law 1999:3).

It follows then that the symmetrical treatment of humans and nonhumans is, to adapt the point (Star, 1991:30) makes in relation to technology, a kind of 'heuristic flattening of the differences between

humans and non-humans in order to understand the way things work together'. On differences, divisions, distinctions and states of being, the analyst's job is to explore how such things come to exist via a sort of 'radical relationality' (Law, 2000). Therefore, what an actor is or is not and what its attributes might be is very much an empirical matter (Doolin & Lowe, 2002). However, the actor-network position is to always start out with an even playing field in which the human and the nonhuman are initially (and only initially) considered as equal and indeterminate entities (Law, 2000). It is argued that this process of *a priori* levelling of differences allows analysis to overcome the boundaries that have precluded analysis from examining the ways in which the human and the nonhuman is interwoven (McLean & Hassard, 2004).

Once one has yielded to the analytical principle of symmetry, moved towards a consideration of all entities as actants and begun the tracing of heterogeneous networks, another issue with the application of ANT raises its head. Speaking of her discovery of ANT during the process of writing her ethnographic experience, (Janet Rachel, 1994:810) states:

> 'I found myself constantly overwhelmed by the number of actants that could be construed at work around me and within me, and I was outrun by the speed at which these seemed to be moving through their networks. In short, I was paralysed by the choice of actants to follow – humiliated by their agility – confounded by their constantly changing forms. Turning everything into an actor was stimulating to say the least. I found that if I took ANT literally and tried to render the networks visible, I lost the power of the theory altogether.'

Despite these statements, (Rachel, 1994) continues to write of the productiveness of ANT in terms of being able to look between dichotomies and examine how things come to be constructed. However, her written statement expresses an issue associated with actor-network accounting – who to follow, who not to follow, who to include and who to exclude (McLean & Hassard, 2004).

In theory, actor-networks are infinitely extendable. They can contain an infinite number of actants and an infinite number of connections. For example, if I sit here and think about the actor-network of this article and try to expose it in its entirety, then I am apt like (Janet Rachel, 1994) to become rapidly overwhelmed and my actor-network is likely to explode. Morover, as I attempt to trace it the actor-network will become increasingly more complex because each one of the actants in this network, in addition to being a actor-network itself, (Law, 1991) is also at the same time embedded in multiple other actor-networks (Star, 1991).

There is a problem in philosophy that it is referred to as *infinite regress* which can loosely be defined as an explanatory procedure that necessitates its own re-application without limit. However, because such an explanatory procedure can potentially generate an infinite number or 'series of conditions or variables', it is considered unreasonable (Audi, 1995: 371). The potential infinity of actor-networks means that any analysis is susceptible to the problem of infinite regress. This being the case, he argues, that it is possible that actor-network theory cannot render anything useful. However, the issue of the extensibility of actor-networks, or to put it another way – that networks are 'multiplicitous and multidimensional' (Michael, 1996: 65, Star, 1991) - is recognised amongst its proponents. Furthermore, actor-network theorists do not, as a rule, attempt to expose their actor-networks in their entirety or consider this necessary. In the case of actor-networks within actor-networks (Michael, 1996) the complex task of accounting for the actor-networks that compose each actant is considered a problem that can be avoided or made easier to deal with through a process of *punctualisation* (Law, 1992).

Law (1992) considers that it is possible to 'punctualise' an actor-network and consider it as a 'single block', that is, as a single actor. In doing so, the associations of heterogeneous elements from which that actor-network is composed are rendered invisible. However, (Callon, 1987) warns that when this is done it must be remembered that behind these punctualised actors there are a mass of invisible others. Each actor then can be considered as a *black-box*. If we wish, or if it is necessary, we can choose to

open the lid of the black-box and look inside to see what constitutes the whole actor-network of the black-box or the sets of complex associations of heterogeneous elements within (Callon, 1986b). This strategy can be applied in blanket fashion. For example, the actor-network which is the focus of analysis can, in itself, be considered as an actor and 'can be compared to a black-box that contains a network of black-boxes that depend on one another both for their proper functioning and for the proper functioning of the network' (Callon, 1987: 95). However, punctualising an actor-network in this fashion has to be treated with caution. Law (1992) warns that punctualisation is precarious. Seemingly stable actors may desert the actor-network they belong to or may be become unstable if new actors enter the actor-network (Callon, 1986a & 1986b).

In part, the issue being discussed is the problem of where to 'cut the network' (Strathern, 1996). If it is not possible to consider *everything* then the actor-network theorist is faced with decisions about which actors to follow and the related issue of determining where the actor-network starts and where it stops (McLean & Hassard, 2004). The end of the actor-network is perhaps the point when the network appears durable and the need to open up black-boxes and examine their contents disappears (Law 1987). However, the issue of where to start and what to follow is more difficult.

The general rule of thumb seems to be contained within the slogan 'follow the actors' (Latour, 1987). As a rule of thumb, it seems a bit vague and implies that one should wait around (or follow around) and assume that what should be followed will emerge (see Law, 1991). Miller's (1996 cited in McLean & Hassard, 2004) advice is more pragmatic and more strategic than this, as he suggests, it is simply a case of picking out what you wish to follow and ignoring what you do not according to which actor-network you wish to examine. In speaking of Miller's advice, (McLean and Hassard, 2004) suggest that in practice things are more uncertain than this.

McLean and Hassard (2004) indicate that this is not a problem confined to actor-network theorists in the field because no researcher can possible follow all actors everywhere. Thus, they suggest, that in reality all researchers engage in a process of selecting and sorting which ones to follow and presumably, as a consequence, which ones to represent. It appears that somehow the researcher has to make an analytic decision as to where the network should be cut and in the process of doing so, remain open to the charge of neglecting those that have been excluded and criticised and for the inclusion of those that have not.

If inclusion and exclusion is the hands of the analyst, then the issue of who is represented in actor-network accounting can be considered equally so. This issue of who actor-network theorists can legitimately claim to represent is closely tied to the debates on symmetry and is discussed in relation to how symmetrical (or otherwise) the treatment of nonhumans vis-à-vis humans is in practice. Here, the sceptical (Collins and Yearly, 1992) have been the most vocal critics on issues of representation arguing that in order to be truly symmetrical, actor-network theorists would need to include the voices of the nonhumans they claim to represent in their accounts.

These issues are raised by (Collins and Yearly, 1992) in their now infamous paper *Epistemological Chicken.* The crux of their argument is that the symmetry principle is, more or less, invalidated because actor-network accounts can only ever be human-centred. They can only ever be so, they argue, because the points of view of nonhumans such as scallops can never be represented. Thus, they ask:

> 'Would not complete symmetry require an account from the point of view of the scallops?' (Collins and Yearly, 1992:313).

As Callon cannot claim to be able to give voice to scallops, Collins and Yearly (1992) suggest that the account of scallops Callon gives is prosaic, despite it being a good exposé of the relationships between humans and nonhumans. This is because it represents an essentially human-centred asymmetrical story. It does so because it presents an account in terms of the complicity of scallops which depends entirely

on a human-centred interpretation of scallop complicity. Collins and Yearly (1992: 313) offer tantalising suggestions on how the point of view of scallops may have been different:

> 'Would it be sensible to think of the scallops enrolling the scallop researchers so as to give themselves a home and to protect their species from the ravages of the fishermen?'

Michael (1996) following Collins and Yearly's arguments suggests that this is a highly problematic issue for ANT, in so far, as actor-network theorists claims to give a voice to 'things', conceals the fact that the voices of things are, in reality, highly dependent upon human mediation. That is, things 'never speak directly – they must always be 'articulated' or rather constructed through human categories' (Michael, 1996: 75). This, it is argued, results in reinstating the social as the true site for sociological investigation. However, as he continues to point out, for actor-network theorists the primary concerns are the associations that take place between humans and nonhumans. The response of (Callon and Latour, 1992) to the criticisms of representation and symmetry is that nonhumans are woven into the fabric of the social and social relations. Therefore, it is the interactions between humans and nonhumans and the properties exchanged between the two that is the object of study (Michael, 1996).

McLean and Hassard (2004) consider that the issue of how objects are represented in actor-network accounts is an important methodological concern and that there is a need to consider how actors are represented and how our conceptual tools and understandings influence this representation. As they point out, 'for Callon, this relies on the observer being agnostic to ensure that no point of view is privileged and no interpretation censored'. However, the issue of how symmetrical representation can really be still remains (McLean and Hassard, 2004: 503).

4.0 Discussion

ANT has been criticised for apparently granting agency to things and in the process reducing people to the status of things. For the most part, these criticisms are interwoven within ontological debates. However, for actor-network theorists this flattening of ontological differences between the human and the nonhuman is an analytical strategy. It is not, as (Law, 1992) reminds us, 'an ethical position'. Thus, and as (McLean and Hassard, 2004) have pointed out, for actor-network theorists, analytical symmetry is not an issue of concern.

However, there are methodological problems that are of concern to actor-network theorists. Problems with where to 'cut the network' (Strathern, 1996), what actors should be followed and which ones should be included remain. Additionally, there are methodological problems with the fact that actor-networks are apt to explode and may be potentially infinite. Advice on the former (cutting the network) is that in following actors things will 'emerge' and what should be followed and included will arise from the act of following itself (Miller, 1996 cited in McLean & Hassard, 2004). The advice here puts the selection of what actor-networks are traced by the researcher firmly in their own hands. However, according to (McLean and Hassard, 2004) that this should be the case is not a situation that is unique to actor-network accounting. The solution to the latter set of problems (exploding networks) is considered to lie in the analytical strategy of *punctualisation* (Law, 1992) as long as the analyst punctualises with caution (Callon, 1986b; Lawm, 1992). The advice here is much more prescriptive than that offered on network cutting, although (Callon, 1986a, 1986b) reminds us that the analyst must remember there are invisible others.

The issue of representation remains highly problematic. Things do not speak. This much is fact and I find Collin and Yearly's arguments in respect to how symmetrical actor-network can claim to be quite legitimate on these grounds (although I have not found an actor-network theorist who has claimed to have been able to authentically represent the voices of nonhumans). However, whilst this issue of representation should be acknowledged in accounting, it does not necessarily imply that the 'first instance' analysis of the associations between humans and nonhumans is not a project worth pursuing,

given that the nonhuman is implicated in the social.

Nonetheless, ANT offers a rich analytical and methodological approach for the study of the social that moves beyond a human centred view. In particular it provides us with a strategy for examining the ways in which effects such as agency, power or social order are created in the associations that take place between humans and nonhumans. For instance through the device of *translation* it is possible to see how effects such as these are generated in heterogeneous networks of people *and* things whether these things be scallops, fishermen or microbes in a laboratory. Exposing these networks and understanding the ways in which these come to be constituted or indeed how they may collapse is the task of the actor-network theorist. Whilst this has not been an extensive or all encompassing review of actor-network theory – its complexities preclude this - it is hoped that this article has provided a pathway through some of the key elements of ANT that allows one to see how, analytically and methodologically, this task can be achieved.

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