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Nurses' Understanding of Health Technology in the Intensive Care Unit

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Abstract
The aim of this thesis is to explore nurses' understanding of technology in the intensive care unit. The study brings together empirical data gathered from nurses' practice in the ICU environment, along with theoretical insights from science and technology studies, to illuminate how nurses' understanding informs their use of technology in their care activities. The empirical data was gathered through intensive fieldwork over a period of 5 months in an ICU department within a large teaching hospital. In addition, recorded in-depth interviews were carried out with ICU nursing staff. The interviews uncover themes such as nurses' practice with technology; nurses' ambivalence around the use of technology in relation to patient care; and nursing identity and professional status. Current theories of technological determinism, social essentialism and technology-in-practice within science and technology studies are examined for their usefulness in illuminating the world of ICU nursing research. In particular, Actor-Network Theory, as an example of technology-in-practice, is utilised as a theoretical lens to explore the contingent nature of social and technological relations on the ICU, where nurses' understanding of technology emerges as an effect of multiple associations between human and non-human actors. The thesis informs existing research by offering further empirical insight into the ICU world through in depth analysis of the semiological and material qualities of technology in the ICU, and develops a number of conceptual themes such as 'balancing patients,' 'chasing numbers' and the 'technology vigil' to frame nurses' understanding of technology. The study also adds insight into the construction of nursing identity, suggesting it is an emergent property of nurses' interactions with technology. The thesis concludes by indicating that knowledge of how nurses understand, use and frame their identity in relation to technology can inform current research into technology adoption and diffusion in healthcare environments.

Keywords: *Nurses' Understanding, Health Technology, Intensive Care Unit*

1.0 INTRODUCTION

1.1 Nurses' understanding of technology in the intensive care unit

Health technology, as an adjunct to nursing care, has burgeoned over the last 50 years. From monitoring devices (Sandelowski, 1997) to computer based patient informatics (Timmons 2002; Ash, Berg et al. 2004) much of modern nursing care would be unimaginable without technological innovations (Walters, 1995). This is particularly so in intensive/critical care nursing, where the development of critical care nursing practice, and the growth in expertise and professional status, has come about as a consequence of health technology developments (Barnard, 2007; Sandelowski, 2000). This growth in health-based technology mirrors the substantive development and deployment of technology in many areas of modern life, both at work and play. Today, more than in any other period, technology extends throughout our everyday activities. Technology pervades, in a qualitative sense, how we interact and do business with other social beings. As Giddens (1990) suggests, the rise of technology, coterminous with modernity, should be examined for both its *extensionality* and *intentionality* in modern living. With a tendency for technology to encroach upon our everyday arrangements, commentators have examined the effects of technology on social existence. In general terms, a tension has emerged between those commentators who write about the determining tendency for technology to dehumanise social interaction (Braverman, 1974; Marcuse, 1964) and those who argue for technology as something which can enhance our lives. With a litany of labour, life, and environmental-saving devices, technology marks, for some, the highpoint of human progress (Feenberg, 1999; Hadjilambrinos, 1998).

If we accept that technology and its interaction in material sociality is widely contested then it is unsurprising that the application of medical technology garners comparable uncertainties. Indeed, many of the wider social anxieties (and for that matter hopes) placed upon technology are mirrored in the application of technology in medicine. To offer a pertinent example, whilst it is technology that makes much 'intensive care' possible, there still remains some degree of ambivalence and uncertainty about the appropriateness of technology in relation to patient care (Fairman, 1992). Given that nursing and medicine have historically been sites for the adoption of new forms of technology (Sandelowski, 2000) it is surprising that technology in nursing has been relatively under researched (with the exception of some work in nursing philosophy (Barnard, 2007; Sandelowski, 1999; Walters, 1995). More notable still, that battles between medicine and nursing have been fought and won over the siting and use of technology and have contributed to nursing gaining professional status (Davies, 1995). One route to a new professionalism has been through

shaking off the less than 'scientific' approaches of the past and in embracing technological developments. However, like all social practices, nursing is a contested field with a set of 'unresolved issues and … tensions' (Davies, 1995, p.13), none more so than the major cleavages in nursing philosophy around the role of technology and it transformative qualities (Barnard & Sandelowski, 2001; Barnard, 2000; Sandelowski, 2000; Walters, 1995). The major moral and philosophical debates surrounding the place of technology within nursing coalesce around a number of oppositional questions:

- Does the use of technology determine the practice of nurses?
- Alternatively, are nurses in control of the technology?
- Does the application of technology in nursing practice enhance holistic patient care?
- Or does technology detract nurses from patient care towards a focus on technological maintenance, resulting in nurses/patient alienation (Barnard & Sandelowski, 2001; Purnell, 1998)?

These questions are perhaps inherently tied to, and formulated within, a macro examination of technology which seeks to 'ground them in a broadly societal context' (Hadjilambrinos, 1998, p.179). Moreover, examined through the lens of 'technological regimes' that operate at the macro level, the answers will inevitably fall on either side of this debate; reflecting views on technology as either somehow harmful to human interaction and sociality, or on the other as an enhancement to social interaction by way of technological progress (Hadjilambrinos, 1998).

In contrast there have been attempts to examine nursing practice at the micro level of human/technological interaction and to unpick the subtle and nuanced way that nurses articulate their use of technology. Crocker and Timmons (2009) explore the transformation of 'medical technology' into 'nursing technology'. They show that the means of transformation is context dependent for nurses, influenced by recourse to professional status, the articulation of moral discourse surrounding nursing care, and also to perceived differences between novice and senior nurses' use of technology. While novices were determined by technological protocols, senior nurses were able to transform the technology through their professional agency and to adapt it to what they perceived to be appropriate utilisation in nursing care. This example from health technology research within science and technology studies demonstrates that a more nuanced understanding of human/technological interaction requires the micro exploration of the immediate context of technology use. Recent studies in health technology have coalesced around the idea of technology-in-practice (Timmermans & Berg, 2003; Orlikowski, 1992), developed as a way to explore the contingent and emergent nature of both social and technological systems. This will be considered further at a later point in the literature review chapter. For now it is sufficient to indicate that this standpoint holds promise by offering a theoretical through which to explore how nurses come to understand and enact their professional identity (Lehoux et al., 2008) and place meaning on their interaction with technology in pursuit of caring for patients.

At this juncture I should disclose my interest in looking at ICU nurses' understanding of technology. The idea for this study originated 15 years ago as a sociology undergraduate at Edinburgh University, although my interest for the work of nurses' reaches back earlier to a period when working as a nursing assistant within psychiatric care. During my degree an interest in science and technology studies was born. Prior to undergraduate study I had always considered technology, gadgets, and indeed most physical objects as mundane entities, their only importance being that they could make life easier if they worked, or make life more complicated if they did not. Machines and devices stood in my mind alongside people, helping or hindering their activities and interactions, but nothing more than that. Choosing senior honours courses in sociology I became curious about a course called 'Technology and Society', intrigued with what this had to do with understanding sociology. Delving in to the world of technology I thought would make an interesting diversion amongst those other courses selected (social theory, methodology, gender studies, etc.) and would provide some real-world knowledge alongside more traditionally academic concerns. Surely a focus upon technology and its relation to science and engineering could be nothing but practical and straightforward?

Evidently ignorant of the Edinburgh School's reputation in science and technology studies I attended seminars run by David Bloor, John Henry, Martin Kusch and others (all key players in science and technology studies at the time) and was fascinated by the insight that they offered. The teaching of Donald Mackenzie I found particularly inspiring. In Professor Mackenzie's course 'Technology and Society' I experienced a turning point in my sociological interests. Here I was introduced to some new and profound theories which seemed to answer a number of hanging question that had not been resolved in the rest of my studies. This had a major impact upon me as an undergraduate as I felt the theories and epistemological understanding from this field could be applied to areas of social life out with technology studies. All material life became an engagement with some form of technology and I learned that there was more to human relations with technology than a striving for greater efficiency. Seen through the various theories of technology and society I now understood how technology shapes our world, mediates our relationships with other humans, and crucially mediates our relationships with other objects. In making this revelation I wanted to bring these

insights to the fore and explore an area of technology and social life with which I was familiar, which brought me nursing and technology.

Although I had worked for five years as a psychiatric nursing assistant, plus many years working in social services, I am not a qualified nurse. My investigation of nurses' interaction with medical technology is therefore not borne of some necessity to understand the role of medical devices as part of any vocational will to power. However, my previous quasi-insider status does provide sufficient engagement and insight to recognise an important nexus of technology and the social. The world of the ICU is replete with technological material and as a student of technology and society this seemed an appropriate site to explore the interaction of humans and technology. A site where at first glance we might presume that nurses' use of technology would be relatively instrumental: technology as tools applied to nursing practice to make patients better, a relatively straightforward situation where if the nurse follows the manual the machine does what it says on the tin as it were.

From the outside there seems nothing specifically sociological with this practical interaction. If sociology can engage with ICU nursing then it is only in as much as nurses share and interact in the space of the ICU environment, and within this perspective it is strictly human-to-human interaction that is the concern of social analysis. The connection between supposed (non-social) mechanical objects and their social contexts of application has hitherto marked a sociological boundary for early thinkers of science and technology studies such as Robert Merton (1973). However, in my academic studies I had come to understand the relations of nursing and technology to be more complex. With the rise of new theoretical perspectives, not least the Strong Programme within the Edinburgh School of science studies (Bloor, 1991), research on technology could go further by breaking down the boundary between the objective practice of science and technology on one hand and social interaction around this practice on the other. Henceforth, the new theories of technology and society would allow an examination of the social constituents of brute machines and indeed the constitution of social relations by technology. As Carmel (2013) indicates the idea of nursing is bound up with notions of holistic care. I am interested to explore this normative view of nursing practice. To consider how it plays out in the technological world of the ICU and is maintained (or re-configured) against a backdrop of public discourses on technology which suggest that care may be undermined in the context of high technology. I also wanted to look at how nurses understand the technology and how they might use it in creative ways that contribute to the social interactions going on in the ICU. In sum, my goal is to explore the possibility of a theoretically informed explanation of those interactions in the technology nursing nexus. I find many of the theoretical perspectives surrounding the construction of technology (social or otherwise) fascinating and my study allows the opportunity to exercise elements of this theoretical canon and to see how far they can travel in my examination of technology in nursing practice. Along the way I hope it proves useful in illuminating the interactions of nurses.

1.2 The Technological Terrain of the Study

In this section I will define the empirical field in which this research will take place. I will lay out the rationale for why ICU nursing is an important focus for understanding nursing care in locations of high technology. However, before considering these points it is necessary for me to define the limits of the ICU-based technology that will be the focus of investigation. Therefore I will outline types of ICU technology before setting clear boundaries on the specific technologies that will inform the scope of the study. In the last section I will offer the research questions which will become the focus for the rest of the thesis.

1.3 Defining ICU Technology

There are numerous devices, artefacts and materials which fall into the realm of health technology, indeed the diffusion of technology in healthcare seemingly increases unabated as new devices, techniques and procedures become established as part of standard practice. Acceptance of this new technology is governed by an array of social actors including health experts and the media who might champion the adoption of new medical devices (Lehoux, 2006), however, against a backdrop of rapid diffusion commentators have emphasized a cautionary message about the lack of effective evaluation of the use and purpose of new technology (in part due to its rapid uptake) (Lilford, 2000; Mowatt et al., 1997). Mowatt et al. recognise numerous examples of, "unevaluated new technologies that have diffused widely and have subsequently been shown to be ineffective or even harmful" (p.15). Although health organizations have a commitment to increasing the use of health technology within ICUs few of these technologies have been scrutinized in random controlled trials to test their effectiveness in reducing hospital mortality (Bastos et al., 1996). Caution expressed by researchers aside, the fact remains that health technology has become an inescapable factor in care practices across all fields of health. The following table (1) taken from Lehoux (2006, p.xvii), although not exhaustive, gives an indication as to the wide scope of health technology.

Table 1: Categories of health technology and examples

As the above table shows each area of healthcare has its own specialist technologies. Although it is important to note that some technologies demonstrate more generic application across a multitude of healthcare settings and clinical fields, the ubiquity of informatics and electronic patients being one such example. With regard to the technology that will be considered in this study I wish to make a distinction between 'hard-technology' and 'soft-technology'. 'Hard-technology' are those freestanding devices and machines used by nurses to help maintain and monitor the vital physiological and biological body functions of patients (see table below for examples). Used in the optimization of patient care and recovery they constitute a growing, and sometimes overwhelming, arsenal of equipment utilized by ICU nurses in their routine care practice (Donchin & Seagull, 2002). Soft-technologies comprise computer software programmes which ICU nurses use as part of their administrative and patient management duties. At its core soft-technology represents a host of computer-based software developed for, amongst other things, the recording and retrieval of electronic patient records. In addition to the new format of record keeping the last two decades have seen an expansion of other forms of nursing informatics (Saba, 2001; Henry, 1995; Romano & Heller, 1990). The American Nurses Association (2008, p.3) define nursing informatics as, "…[A] specialty that integrates nursing science, computer science, and information science to manage and communicate data, information, knowledge and wisdom in nursing practice". The growth of internet-based technology has generated a wealth of diagnostic information which is available to nurses and raised expectations that nurse practitioners will utilize this store of knowledge to inform patient treatment, for example in the burgeoning area of risk prediction modelling (Rosenberg, 2002).

Although these two forms of technologies are in some instances considered together under the general expansion of health technology this study makes a clear distinction between them and focuses exclusively upon 'hard technologies'. 'Soft' technology and informatics are acknowledged as important components of nursing technology research (see Jensen et al., 2009; McCormick et al., 2007; Smedley, 2005) but it is not the focus of this study. Given the amount of technology in use in health care it is necessary to demarcate the technological terrain of this study. This study will consider solely that technology which is most often applied in intensive care units, specifically those devices and machines that ICU nurses use as part of their everyday practice in supporting patient care. The following table (2) taken from Bastos et al. (1996) provides a list of available technologies used within intensive care units, although it is of course sensible to note that technology use varies from patient to patient and that patients may be exposed to single or multiple technologies at any one time.

Health Technology Category	**Examples**
Screen tests	Cytological tests, blood tests, prenatal testing, genetic testing
Diagnostic tests and imaging devices	X-rays, ultrasound, magnetic resonance imaging, computer tomography
Implants	Cochlear implant, pacemakers, heart valves
Surgery/ therapeutic devices	Hip replacement, laparoscopic cholecystectomy, radiation therapy
Palliative technology	Ventilation, dialysis, syringe drives, profusion devices, nutrition
Health promotion technologies	Vaccines, condoms, public health initiatives, sports and exercise facilities
Information technologies	Telemedicine, electronic patients records, expert systems

Table 2: Technology within intensive care

Electrocardiograph monitor
Pulmonary artery catheter
Tran venous pacer wire
Defibrillator
Intubation equipment
Infusion pumps

Continuous positive airway pressure apparatus
Mechanical ventilator, volume
Cardiac pacemaker
Ventilation device
Pulse oximeter
Doppler ultrasound
Portable electrocardiograph
Haemodialysis
X-ray (portable)
Intracranial pressure monitor
Ventriculostomy (monitor)
Continuous arterial-venous hemofiltration
End-tidal CO2 monitor
Intra-aortic balloon pump

Whilst the above list was derived from a paper laying out current technology circa 1996, it is a given that new technology trails are a constant feature of intensive care medicine (Baldwin, 2002).

Through their use these devices represent a series of practices, interventions, and procedures carried out by ICU nurses. At any given time nurses are monitoring and recording the 'pulse' of technology as a proxy for patients' human physiological status. Indeed technological competence displayed by nurses in monitoring patients in this way is, in many respects, *the* demonstration of a nurse's competence within ICU treatment (Wilkin & Slevin, 2004; Locsin, 1989). In their study looking at the meaning of caring among ICU nurses Wilkins and Slevin (2004) indicate that, "acquiring technical competence, knowledge and professional experience" (p.54) was viewed as a step to becoming confident ICU carers. The rationale for exploring those particular technologies that interact with, and in some instances maintain, physiological and biological functions is to 'get up close' to nurses' experiences of the human/technological interface. At this level things start to get interesting in terms of the boundary between patients and technology - for nurses in the ICU a constant focus on the machine-human interaction marks this site as a liminal space where they are neither fully focused upon the patient nor fully absorbed by the machinery. Barnard and Sandelowski (2001) in their study of humane care and technology put this interactional feature in this way: *"Although it is common to categorize technology as nonhuman, pacemakers and artificial joints implanted in living human beings… regularly confront us with the reality of and potentiality for living artefacts and vital machines. These cyborg [elements]… blur the line between animate and inanimate, and human and machine."* (p.368)

Barnard and Sandelowski use the term 'cyborg' to define the interplay between the human and the technological, although they also suggest that establishing a boundary between technological care and humane care is misleading. They argue that technologies' supposed de-humanising features are neither universal nor inherent in the application of machines to human care. The notions of technology, nurses and patient are all socially constructed. Taking up a social constructivist/ social shaping position Barnard and Sandelowski (2001) view the meaning of technology as deriving from its context of use. Research must, they insist, stand back and take notice of the context and interaction between nurses and machines and describe the micro interactions between actors (I include nurses, patients and machines as actors in this interplay). Only in the unfolding of action can we assess the impact of technology upon the understanding and meaning nurses bring to their caring practices. This I believe is an interesting conceptual space in which to explore the experiences of ICU nurses. For, if there is indeed an unbounded space existing between patients and technology, then this has to be mediated by nurses through their representation of both the technology and the patient. This mediation brings to the fore questions about identity both for the patient and nurse, irrespective of whether or not in the interface between patient and technology (a space of blurred representation) the patient's social identity is lost. In terms of nursing care in ICU environments the question to ask is 'what is being cared for?' At the same time through the interplay between patient, technology and the nurse we may also ask who is doing the caring. Thus it may also be contended that the nurses' identity is also configured in the unfolding interactions between the patient and technology (Lehoux et al., 2008). In this respect the interplay of both patients and nurses with technology represent the hybrid nature of human and technological interactions (Lapum et al., 2012).

Donna Haraway (1994) also invoked the spectre of the cyborg but hers is a space for play that permits new techno-human identities that transgress representations of hitherto subordinated (feminist) identities. However, in their research on death in intensive care Johnson et al. (2000) suggest that contrary to Haraway's utopian enterprise patients might equally experience a fundamental loss of identity. The authors state that: *"The body, encumbered by invasive equipment transfigures the patient into a cyborg of sorts, making his or her humanity and biological selfless recognizable."* (p.284). In the realm of medical and nursing technology I believe that these points where human and machine coalesce present a vertiginous experience for nurses as they work through their care-giving priorities -

between technology and patient. There is, I believe, a call to investigate ICU nurses' understanding of the relationship between machines and humans when, as has been suggested from previous research, there is a blurring of the distinction between human physiological status and technological monitoring.

1.4 Nurses' understanding - defining the research questions

This thesis explores nurses' 'understanding' of technology. What then do I mean by nurses' 'understanding'? I use the term to define two aspects of nurses' interaction with the ICU environment. Firstly, how nurses comprehend the activities and practices in which they are involved and are thus able to explain their actions and derive meaning from the actions of others. In this way, the world of ICU is meaningful to them as a shared (though at time contestable) set of practices, culture of artefacts, signs and language which all participants have a hand in re-producing. If they are asked a question or if something is pointed out to them, in terms of their interaction with technology, they would be able to explain through language what a given set of affairs means to them. Secondly, understanding describes their ability to produce and re-produce the world of ICU as a set of embodied practices which could be said to be pre-cognisant, i.e. without conscious thought, which nevertheless respond to meaningful signs - akin to Polanyi's (1962) idea of tacit knowledge. It is a level of 'understanding' that takes its shape through embodiment in relation to the material world of ICU technology. The embodied nurse in interaction with technology 'knows' the permissions and prohibitions, knows where they can and cannot go in technology assigned space. This, however, does not limit the possibility for spaces to be reconfiguring; spaces have contingent properties and are changeable (Bingham & Thrift, 2000).

Similarly, in the semiotic world, all actions in context, including those of ICU nurses, have a textual quality which can be 'read' for meaning (Law, 2009; Grint & Woolgar, 2000). Therefore, when I write about nurses' 'understanding' I have two properties of understanding in mind: one carried in mundane and everyday thought and language, the other within a complex flow of embodied actions corresponding to nurses' tacit understanding of signs and symbols in indexical meaningful contexts. Sonesson (2007), in his exploration of embodiment and semiotics puts it like this: *"We shall say that what is of primary importance to semiotics is operative knowledge- i.e. knowledge that must exist at some, probably low, level of awareness in order to render behaviour as understandable (and thus explainable)".* (p.7). There are methodological and epistemological implications for this use of 'understanding'. Above, I mentioned two properties of nurses' understanding. The first is acquiring through nurses' accounts of their understanding of a situation, which is best achieved through in-depth interviews, which I used for data gathering. Here, understanding of a given interaction is expressed through verbal communication. The second, more speculative property is that through observational techniques I can explore the embodied understanding of nurses in the meaningfully co-produced space of the ICU. With these details on understanding discussed, the purpose of this study will be to explore nurses' understanding of technology in the ICU, and how the application of health technologies informs nurses' professional epistemologies (Edgley et al., 2009) with regard to the care they offer patients. The specific questions to be explored are as follows:

- In what way does nurses' understanding of technology in the ICU, mediate in their use of the technology?
- Does technology mediate nurses' ideas and representations of patients and the forms of care they provide through technological regimes?

2.0 LITERATURE REVIEW

This review covers three distinct areas pertinent to the exploration technology and ICU nursing. Firstly, I will explore and review a number of theoretical perspectives or standpoints that have driven much of the literature and research on technology and society. To frame this literature, and the theory explained therein, I will adopt a threefold taxonomy developed by Timmermans and Berg (2003). Their framework is particularly useful as its focus upon research in health technology is supplemented by the authors' consideration of wider theories and debates from the field of Science, Technology and Society (STS). My purpose with Timmermans and Berg's classifications will be to expose some of the explanatory weaknesses that are bound up in adopting the first two of the authors' classifications - technological determinism and social essentialism. In doing this I will follow the authors' suggestion that any thoroughgoing research requires an exploration of technology-in-practice. In this respect, I agree with their conclusion and therefore consider Actor-Network Theory (ANT, hereafter), as an example of Timmermans and Berg's third category of 'technology-in-practice', as a lens with which to explore nurses' understanding of technology in the ICU environment. I follow these classic theories of technology by looking at material concerning the implications of technology for nursing practice, considering here a body of work generated by nursing scholars. It will be seen that the technology standpoints outlined in the first section have informed the arguments for and against the use of technology in nursing care.

In the third section I will look at the literature pertaining to nursing as a profession. The classic position in the literature is that nursing has to a great extent remained subordinate to medicine, particularly in the context of the hospital. However, recent material has contested this as nursing academics have strived for theories and models of practice which are different to those applied in medicine. Nursing is about care not cure; it is about holism and not the objectification of patients. In practice, however, it may be difficult to conceive of nursing as a singular discipline (May & Fleming, 1997) . With this in mind, I will go on to look at how the literature conceives of medical technology as a mediator in the construction of nurses' identities and care practice. Critically however, I suggest that this literature never fully engages with the actuality of technology-in-practice. By understanding nurses' practices around technology we will find that medical devices have a role to play in the configuration of those practices and contexts beyond being mere conduits to nursing practice.

2.1 Defining Technological Standpoints

From their previously marginalised position in social science, technology and science have emerged as areas for sociological investigation in the last fifty or so years (Feenberg, 1999; Woolgar, 1988). Prior to this few writers, with the exception of Marx's (1867) writing on industrialisation, capital and historic development, explored the ontological import of technology within human activity - a lacuna that with hindsight now appears extraordinary given the ubiquity of technological devices in human history. It was not until the late modern period that scholars considered technology as a mediating phenomenon in social life. The turnabout in the socio-technical insights of commentators was as a consequence of increasing prevalence of high technology in both work and everyday life. Of course, technology had been part of craftwork (and nursing) since pre-modern times. Two rival positions emerged with contrasting views on the influence of technology upon human conduct. On one hand technology was regarded as neutral with humans in control of technology for the benefit of social progress and individual happiness. Thus, for example, innovations in industrial efficiency would increase productivity, heralding a new epoch of technologically-enhanced prosperity for all (Graham, 1998). Others viewed technology as a determining monolith which in time would pervade all human endeavours. Even the ideas that shape human goals would be determined by the rationalisation of means brought about by technology (for an overview of these positions, see Feenberg, 1999).

Nursing, especially ICU nursing, has not remained free of these technological arguments, indeed the conflicting perspectives of technological neutrality and determinism have entered the canon of nursing research (Barnard & Sandelowski, 2001; Barnard, 1997, 1999). Barnard warns that technology in nursing does not assure linear progress, although science and technology may achieve medical efficiencies. Nevertheless, Barnard wishes to point out, in somewhat deterministic fashion, that the pursuance of technological progress in relation to nursing practice does bring with it changes in nurse/patient relationality. Barnard (1999) insists that: *"The act of including machinery and equipment in nursing introduces patterns of techno-logical activity that by their very nature change nursing practice, our roles and responsibilities, and the way we organise our profession and patient care."* (p. 436) However, throughout the last century developments in these perspectives have given rise to more nuanced reporting of technology's role. It is therefore pertinent to investigate how the refinement of theories is encapsulated in research into technology and nursing and medical practice.

2.2 A Framework of Medical Technology

In their broad review of medical technology Timmermans and Berg (2003) define three approaches adopted in the sociological literature to investigate medical technology. I will use this taxonomy to explore the literature on classic technology in society. Timmermans and Berg's definitions are then used to draw out the particular conceptualisation employed in research concerned with technology in the field of nursing practice. Although it should be noted at the outset that a great deal of the nursing literature on technology involves writers, consciously and unconsciously, 'black boxing' technology (Callon, 1989): where the devices mentioned are pre-configured in the analysis as 'closed' and incontestable objects. Indeed, in much empirical ICU nursing research the focus is confined to the social activities of nurses with scant regard to the impact of machines in forming the nursing activity (McConnell, 1990). Framing technology in such a fashion is indicative of a position of technological neutrality. However, as I will suggest towards the end of this section, beneath the surface of technological neutrality there are considerable power relations operating around technological artefacts. The technology perspectives discussed by Timmermans and Berg (2003) are based upon wider scholarship from science and technology studies, scholarship which is highly pertinent to the world of medical technology. The three approaches to technology Timmermans and Berg address are, "technological determinism, social essentialism, and technology-in-practice" (p.99). I will discuss each approach in turn.

2.2 Technological Determinism

The technological determinist perspective holds that technology determines the interplay of social activity**.** From this theoretical standpoint technology enters society transforming the ways in which people mediate relations among each other (Webster, 1991). This determinism extends to economic, political, as well as social arrangements. As a standpoint this somewhat oversimplified perspective is captured in ideas of raw cause and effect relations, where technology wholly mediates interaction causing the setup of prescribed worldviews. As a uni-directional approach, from machine intervention to human change, technology is itself un-mediated by the very social arrangements it instigates (MacKenzie & Wajcman, 1999). In its radical form, expressed in the work of Heidegger (1975), the determining quality of technology not only manifests in social action, but also dramatically determines the thoughts and values that define social action. Thus, according to Heidegger (1975), the essence of technological advancement in modernity ensures a tipping-point where technology heralds a new world-view in which rational calculation becomes the appropriate solution to the problems facing societies: *"Everywhere we remain un-free and chained to technology, whether we passionately affirm or deny it. But we are delivered over to it in the worst possible way when we regard it as something neutral; for this conception of it, to which today we particularly like to do homage, makes us utterly blind to the essence of technology".* (p. 4). Although Heidegger's view appears overly pessimistic writers have commented that the techno-rationalisation of society has had more impact as an ideological feature than as an empirical fact of modern living (Feenberg, 2005; Centeno, 1993).

Against the background of the technological determinism debate, in the field of medicine and nursing the general determinist perspective has fuelled debate across the spectrum, between those that view technology as objectifying the nurse patient relationship (Donchin and Seagull, 2002) and those that believe machines can help the subjective inter-relations between nurses and their charges (Verhulst, 2008; Barnard, 2002). Relevant to the world of ICU, detractors to the proliferation of technology in intensive care point to life-saving devices as substantive evidence of technological 'can-do' overtaking decisions that ought to be constituted in the sphere of human moral values. Thus, those who advocate for a 'dignified death' submit that, "…technologies signify the far-reaching medicalisation of the dying process" (Timmermans and Berg, 2003, p.100). The imposition of technologies and techniques generate a mind set in ICU practice which, according to Timmermans and Berg, denies the patient autonomy over their last moments by extending their death through the machines.

2.3 Social Essentialism

The social essentialist perspective on technology could be said to lie at the opposite end of the spectrum to determinism, although it also problematises socio-technical interactions (Feenberg, 1999, 2005). This broad definition covers a series of social determining standpoints in relation to technology, including the social shaping of technology [SST] and the social construction of technology [SCOT]. Social essentialism as defined by Timmermans and Berg (2003) encompasses a standpoint whereby, "medical technologies are viewed as blank slates to be interpreted and rendered meaningful by culture" (p.101). The view from the social essentialist perspective is that technologies, their innovation and use are wholly dependent upon social arrangements and human interaction. In this way it is social arrangements that determine the outcome of technology, rather than the (supposed socially neutral) fields of technology and science (MacKenzie & Wajcman, 1999). As an indicator of the social shaping of the technological world it has been suggested that particular forms of social essentialism falter due to the reductive nature of technological explanation given over solely to social causes. Therefore, social essentialism shares similar problems to that of technological determinism in its narrow explanation of the emergence of technological artefacts. As Timmermans and Berg (2003) indicate, those who favour social essentialists in medical technology take machines as the material that mediate the world-making interactions of nurses, doctors and patients, "technologies function as sociological catalysts: they are tools that generate interactions or social meanings but do not act, affect, or evolve in themselves" (p.101).

At its extreme, social essentialism/social shaping of technology implies that the uses, formation, invention and innovation of new technology rely for survival on their ability to be fit for purpose in social relations. However, Williams and Edge (1996) insist that in order to avoid essentialism, scholarship must engage with the complexity of technological artefacts and their relationality to a host of spheres of life: In *"In seeking to grasp the complexity of the socio-economic processes involved in technological innovation, SST has been forced to go beyond simplistic forms of social determinism which, like technological determinism, see technology as reflecting a single rationality for example an economic imperative, or the political imperative of ruling elites."* (p.866). Though I would agree with William and Edge on the multi-faceted understanding needed to place technological innovation I would also add a critical point that the economic and political spheres are in essence also social forms of life. This all suggests, following Bloor's (1991) writing on scientific knowledge, that when theorising technological development there is a need to appeal to a 'generalised symmetry' between technology and human interests in their political, economic and social forms. For technology to be 'successful' it has to 'work' across multiple social worlds as well as in the realms of science and

technology innovation. That is to say that the innovation/device may succeed as 'technology' (as assemblies of semi-conductors, circuit boards, pumps and levers and the like) whilst as a social object it may never be received. The point of socio-technical symmetry is expressed by Andrew Webster (2002) when he states: *"[T]echnologies are only really successful when they make sense within the existing social relations within which they are to function, suggesting the crucial role played by the translation and even reinvention of technologies into everyday contexts of use."* (p.444)

If technology is to 'work' it must own, or be in imputed with, social dimensions; so what counts as a useful device has as much to do with its malleability as a symbolic object in the constitution of social relations. The importance of the symbolic content of devices is made apparent in work by Timmons, Crosbie and Harrison (2010) whose examination of the automated external defibrillator (AED) and its use in public spaces demonstrates the semiotic/symbolic dimension when such devices are used to enact 'resuscitation' even though first-aiders recognise the victim to be already dead. In descriptions provided by aiders the performative nature of their actions with the AED symbolised that recovery was viable in order to displace the announcement of death to a more appropriate space e.g. hospital. Following Hutchby (2001) such use of the AED demonstrates the device's social affordances beyond its technological affordances of heart defibrillation. In the research by Timmons et al., they argue that the social imperative to displace death in public spaces is a response to a shared death taboo. Thus the performative action of 'resuscitation' using the AED technology was a response to this taboo and a clear example of the shaping of technology to social and cultural ends.

Among the writings in the social construction of technology (SCOT) Pinch and Bijker's example of the ascendancy of user groups in the development and changing features of the 'ordinary' bicycle is a classic example. Generally, in this approach the shape and use of technology becomes a disputed object contested by, " relevant social groups who play a role in the development of a technological artefact…[T]ypical groups might include engineers, advertisers, consumers and so on" (Pinch & Bijker, 1984, p.113). Technological artefacts in the idiom of SCOT research are open to social inscription, where the use and control of any device is mediated in the interaction of social actors. Of course, whoever invests in the technology does so in relation to other social investments. The nursing and technology literature is suffused with the understanding that technological adoption and adaptation comes as a contingent aspect of other social, economic and political interests (Poland et al., 2005). Questions about the 'ownership' of health technology and about its use in practice are hotly debated, contested both in policy and in practice among medical and nursing bodies (Elston, 1997). Higher levels of professional power and status may be inferred by nurses, doctors and allied professionals (as the relevant social groups) as they claim and employ technology as an aspect of their particular professional role (Crocker & Timmons, 2009; Barnard, 2007; Webster, 2002, 2007). Indeed, Barnard (2007) has argued that the standing of science and technology has benefited intensive nursing as it manages the translation of technology and technological application into ICU care. Through employing sophisticated technologies in ICU nurses have set about converting the meanings surrounding ICU patient care into practical science in action (Dean, 1998). In a discussion of the issue of science in nursing, as opposed to nursing science, Dean (1998) defines the practical challenges in medical technology environments, which make scientific knowledge suitable for ICU nursing in particular: *Technology is the application of scientific principles… it requires nurses to have an increased awareness of the science involved, for example, a knowledge of electrophysiology for correct interpretation of data shown on an ECG monitor, or an increased awareness of the science involved if complications are to be averted due to equipment failure or misuse, so in this way some may well say that it has increased the science in nursing.* (p.205)

In social essentialist terms, the suggestion is that nurses are using the technology symbolically, establishing a 'science' of nursing as a form of professional activity. Knowledge of how the machines work can subsequently be used in mediating status interactions with medical staff. However sophisticated the standpoint of social essentialism claims to be in relation to the determinist position, the criticism levelled at essentialism is it says nothing substantive about the technology beyond its manipulation by social groups (Timmermans and Berg, 2003). What is missing from analysis is the way that medical technology for example, becomes crucially involved with the care of patients rather than passive instruments and tools that facilitate the practice of nurses and doctors.

2.4 Technology-in-Practice

The third position discussed by Timmermans and Berg attempts to supersede the previous two standpoints of determinism and essentialism. If determinism gives too much power to technology in determining social arrangements, and social essentialism reduces the importance of technological objects in the construction of the world; then theories that adopt a 'technology-in-practice' perspective resist differentiating between 'social' and 'technological' achievements, preferring instead to examine the interplay of socio-technical systems (Latour, 2005). Timmermans and Berg argue that theories of technology-in-practice like ANT place technology firmly in the immediate social world, where technology along with social context, relations and identities are co-producing (Law,

2008). That is to say, social relations and identities are produced through practices with technological objects while at the same time technology and the meaning attached to it are constitutive of social relations. ANT, to some extent, both encapsulates the issues based in the classic theories presented by Timmermans and Berg (2003), but also offers new insights into the real world dynamics of humans and technology in action.

ANT endeavours to sidestep the ontological minefield of agency vs. structure and nature vs. social, by insisting that the 'social' should be viewed as networks of associated things we might call 'human' and 'material' (or natural) objects. By bringing together and levelling out these oppositions, ANT suggests that perhaps these divisions, and everything that goes into making them up, share the same ontology. There is in ANT an adherence to the idea of equivalence, not only between agency and structure, but also the idea of a 'generalised symmetry' between the social and technical worlds: between humans and material objects (Callon, 1986a). By extending the implications of technology-in-practice all things in networks associated with the ICU (ventilation machines, nurses, beds, patient records etc.) must be analysed in the same terms. What if, asks ANT, the divide between big things such as hospitals and small things like face-to-face interaction or nurses' monitoring were looked upon as the effects of networks of material and human relationality. It is not that ANT eschews the idea of binary divisions; it is just that these outward appearances are the result of network effects. As Law (1999) argues: *"[I]t is not, in this semiotic world, that there are no divisions it is rather that divisions or distinctions are understood as effects or outcomes. They are not given in the order of things".* (p.3). In their survey of 25 years of medical technology theory Timmermans and Berg claim that a technology-in-practice approach to medical devices and social relations offers the way forward. With this in mind I shall follow the action of ICU nurses in proximity to high technology and describe the patterns that emerge through their performative interaction. Following Timmermans and Berg's (2003) recommendations I aim to use ANT as a theoretical lens by which to explore and illuminate my interview data, revealing the ever-changing flows and dynamics of nurses' interaction with technology. In the next section I will elaborate on some key concepts within ANT to highlight its technology-in-practice credentials.

2.5 Actor-Networks as a theory of technology-in-practice

Bruno Latour and Michel Callon (1981) along with John Law (1986) as early exponent of ANT, insists that ANT was never meant to be a theory. Law sees the approach as a set of tools to be adopted to aid the telling of stories of humans and things. The application of ANT according to Law lies more in describing empirical case studies, it is a methodology, a set of tactical lenses with which to mediate the complexity of human-material relationality. In the following missive Law (2008) imputes the real-world purpose of actor-networks: *"[T]he actor network approach is not a theory. Theories usually try to explain why something happens, but actor network theory is descriptive rather than foundational in explanatory terms, which means that it is a disappointment for those seeking strong accounts. Instead, it tells stories about "how" relations assemble or don't. As a form, one of several, of material semiotics, it is better understood as a toolkit for telling interesting stories... More profoundly, it is a sensibility to the messy practices of relationality and materiality of the world"* (p.7).

ANT explores the inter-relationship of technology and humans at the actual sites of interaction. At these sites ANT holds back from concluding apriori the ontological primacy of human or technology, preferring to wait to be illuminated by the performative nature of human-machine interaction. ANT, broadly described, is a practice theory approach to technological change and development (Greenhalgh & Stones, 2010). It seeks to explain how socio-technical relationships develop and change by recourse to interactions that include individuals, institutions and the technologies themselves. ANT insists that actant entities arises out of the effects of performative action, "entities achieve their form as a consequence of the relations in which they are located" (Law, 1999, p.4). In this perspective there is the potential for uncertainty and contingency, in that the 'order of things' is not the structured input which pre-figures and shapes the nature of human/technology interaction, but crucially the outcome of the relations between humans and technological artefacts. Thus, the potential openness and contingent nature of the situation allows for other forms of action and meaning to arise.

In later developments in ANT, as Law mentions above, the semiotic element of material interaction became a dominant component of analysis. It had been previously touched upon, in early ANT studies through notions of representation of *particulars*; particulars being the individual elements of networks, which later came to be called actants (Callon & Law, 1982). However, later ANT studies would bring the semiotic relationality to the fore through the symbolic ordering of actants in networks. Associations of things could be viewed as the co-production of textual inscriptions (Latour, 2005). The up-shot was that the act of reading and ordering texts became profoundly more contingent (Law, 1999, 2009), with the possibility of alternative readings have the potential to destabilise efforts towards network constancy.

2.6 Enrolment and Translation

The job in hand for network builders is to enrol actants (human and non-human) into network alliances through what Callon and Latour (1981) call the 'translation' of actant entities. Actants for ANT theorists are all speculative entities, both human and non-human that play a part in the building of network alliances. In order to accomplish the ordering of the actant onto networks these builders need to ensure that the particular interests of individual actants are manoeuvred and reframed in such a way as to tie into the concerns and goals of the network (Callon, 1986b). The work of network builders, if successful, ensures that obligatory points of passage (OPP) into the network are formed. Ensuring translation, or reconfiguration, of all actants is important for the network if it is to remain durable in its effects. Network engineers have strategies which ensure durability over time (Callon & Latour, 1992). However, keeping networks together is a struggle; they are largely fragile entities that rely heavily on their continued enactment or performance. These enactments from network-actors both bring the network into existence and reproduce the effects. As Law (2009) indicates, "they hold themselves together but they do so precariously. All it takes is for one translation to fail and the whole web of reality unravels" (p.145).

2.7 Black-boxing and networks as knowledge systems

What comprises the network of actants that health professionals so deftly co-opt for effecting socio-technical relationships? For a start the medical technology (ventilators, monitors, dialysis, infusion devices) all comprise in their own way networks of expert systems. Further actants might include technology training manuals, courses, and the mass of hospital and company personnel, designers, engineers (all of whom will be immersed in other networks of their own). The important thing is if a network is to remain stable these components need to be black boxed, that is contained and secured as durable, and thus useful, objects/actants in order for them to operate to any effect. For example, a medical protocol could be described as a black box in that it may incorporate a number of elements such as medical expertise, planning and hospital governance. These have all been stabilised at other times within organisational systems and have probably involved numerous actors and objects in the process. As a protocol, all these disparate elements have now been coalesced and stabilised as a black box which establishes a correct diagnostic procedure. This is how network influence operates: heterogeneous engineers, or network builders, gain local influence from drawing the forces of black-boxed technology, which are transmuted through the network.

In a mundane sense, all actants carry on in their own sphere of influence. The nurse as 'patient advocate' and 'technology expert' emerges likewise in her/his own micro sphere of interaction. In this space the accumulated forces within the network, made up of so many black boxes, are used to influence the socio-technical interactions. Influence taken from the network also operates as a form of symbolic power; I mean by this, doctors and others recognise and relate to nurses as technology experts in the semiotic circuit of meaning that makes up ICU world. This is, as Law indicates, material semiotics or relational materiality at play, whereby the shared understanding becomes the source of meaningful interaction (Law, 2009). Nurses appropriate this power interaction enabling them to further shape the meanings associated with their activities. This brings into focus the work of 'mediators' and 'intermediaries' within networks. The function of the intermediary in a network is to operate as a fixed and stable black box. As a component in the assembly of elements intermediaries neither add to nor diminish the effects of the socio-technical network. This is to say, in the case of a technological artefact, the device operates purely within the remit of its technological affordances as directed by the network of designers and manufacturers of the technology (Hutchby, 2001). Latour (2005) describes the opposite of an intermediary as a 'mediator'. The implication of this binary set suggests that mediators in fact are crucial to network change. According to Latour (2005): *"An intermediary…transports meaning or force without transformation...mediators transform, translate, distort and modify the meaning or the elements they are supposed to carry."* (p.39)

Here I would like to suggest that adopting an ANT approach to the empirical and analytical matters of ICU nursing allows the setting aside of the classic models of technology and social interaction without losing the core implication of each standpoint. Whilst it should be noted that each one of the standpoints constitutes a particular modality of technology and social relationality that in any observable instance could be apprehended empirically it would fail the complexity of interaction, especially when considering the temporality of action, to stick to one mode of explanation. ANT as a technology-in-practice approach can, at the same time, subsume the classic standpoints of determinism and essentialism by insisting that perspectives of technological determinism and social essentialism are an outcome effect of particular network associations.

2.7 Technology and Nursing Research

Having selectively explored some of the classical perspectives on technological analysis and introduced Actor-network theory as a technology-in-practice model I now want to survey research from the field of nursing which has embodied the arguments from the Science, technology and Society literature. Much of the wider theory of technology that has entered nursing scholarship has been reframed to include concerns particular to nursing,

specifically around the anti-human/cure-centric (as opposed to care) perspectives held by scholars who argue against the imposition of technology in medical practice.

Research in the field of nursing related to technology indicates that on face value technological cure and nursing care lie at opposite ends of a spectrum of nursing practice (Barnard & Sandelowski, 2001). Technology is seen as both mechanistic in its materiality and rationalistic in its ideological form. It is inattentive to ideas of expressive and empathetic care (Watson, 1988) whereas nursing represents a defined moral approach to care (Heskins 1997; Barnard 2002). To emphasise the dichotomy between technology as cure and nursing as a theory of care Gadow (1989) talks about the imperative of nurses advocating for patients which is made problematic by the disembodiment and fragmentation caused by the weight of technological scrutiny. So on one hand we have the perspective of nursing care as a humanistic endeavour specifically aimed at understanding and treating the whole patient (not just their condition). In this particular formation the relationship of carer (nurse) to patient is subjective - containing a degree of emotional empathy on the part of nurses. On the other hand in high-technology environments, such as ICUs, care is replaced by an emphasis on cure (Watson, 1988). In this context attention is directed to the technical monitoring of specific conditions and not to the patient as a whole being. Sandelowski (2000) states that in the power struggle between care and cure the technological ascendancy in nursing has left nurses struggling to define the meaning of the care ethos in their practice: *"We nurses (and others) have variously charged medical technology with the dehumanization, depersonalization, and objectification of patients and of nursing care: that is, with depriving patients of their individuality, subjectivity, and dignity as human beings, with creating the alienation between self and body, and with separating nurses from their mission to care."* (p.367)

In summary, much of the literature warns that technology has the propensity, when introduced to nursing care, to direct nurses' attention to the device resulting in the supposed objectification of patients (Schaufeli et al., 1995). With reference to the determinist model, technology is invested with deterministic qualities that shape nurses' practice. Both Sandelowski and Barnard, prominent writers on nursing and technology, acknowledge the potential for technology to side-track nurses' best intentions towards the device (Ozbolt, 1996). In the same way Barnard (2000) points out nurses are required to reflect upon their involvement with the techno-environment to safeguard their holistic care intentions. Nurses, he concludes: *"Cannot use technology without also, to some extent, being influenced by its use...Nurses expressed disquiet about their experience of alteration to free will. In particular, they believed that their ability to display many of the caring behaviours associated commonly with nursing, such as placing the person as the central focus of care, were being challenge."* (p.1142)

In contrast to this, epistemic split between holistic care and fragmented techno-monitoring, is the perspective that far from reifying and objectifying the patient/nurse relationship, technologies, in their perfunctory purpose of carrying out mundane tasks, actually enable nurses to focus on the delivery of holistic care (Alasad, 2002; Heskins, 1997). In this account technology enhances, not detracts from, the moral care role of nurses (Cronqvist et al., 2004; Cooper, 1993). For many academics researching nursing practice technology is often taken for granted and seldom given the theoretical attention required for a more subtle reading. Technology is background to the foregrounding of nursing care and as such is neutralised as a tool in practice (Hanlon & Carlisle, 2009; Hoerst & Fairman, 2000; Barnard, 1997). Technology neither determines nurses' actions; nor is it inferred that nurses shape the application of the technology through their practice (Barnard, 2007). It is purely an instrumental relation, in that technology offers rational solutions from a neutral place outside of the social manifold (Feenberg, 1999; MacKenzie & Wajcman, 1999). Of course, as Feenberg indicates, the neutral standpoint is in itself ideological in reality. Where technology is ignored because of its prefigured neutrality, or indeed employed in discursive and material practices for its enshrined properties of rationality, it is always already inculcated in a socially constructed political perspective (Feenberg, 1999). This implies that in the context of real nursing practice the interplay of technology and care is more complex and nuanced than theories which settle for dualistic interpretations might indicate.

2.8 Expanding the concept and role of technology in nursing

We therefore need to extend the concept of technology to encompass not only the material objects that nurses use (monitors, diffusers etc.) but to include along with these 'hard technologies' nurses techniques, skills, knowledge and systems of practice as forms of 'soft technology' (May & Ellis, 2001). Theorising nurse practice itself as a form of technology thus allows the examination of 'care' as an activity not solely associated with humans. If we take nursing practice as an evocation of technological practice this allows the inclusion of technology as an enhancement to profoundly sensitive forms of care (such as that surrounding death) rather than as an obstacle detrimental to 'humane' care. Thus, Latour (1990) suggests that technology, beyond its functionality, is also invested with symbolic meaning, and that these meanings can be invested in interactions between nurses and patients. Technology may thus be invested with moral action just as humans may be deemed to be able to act morally. For example, the heart monitor has built in alarms alerting nurses at crucial points to take moral and ethical actions, such as to resuscitate. This effort by non-

human technology to compel humans towards moral forms of action Latour (1992) describes as *prescription* and defines it as the "behaviour imposed back on to the human by non-human delegates... [it is] …the moral and ethical dimensions of mechanisms" (p.225). Adopting an analytical position that closes the spectrum between nursing as the focus of moral care and technology as a reification of moral care, and which moves towards a truer picture of nursing practice (Barnard, 2007; Jones & Alexander, 1993).

Arguments over the role and constructive practices of nursing have a profound impact on the way nurses' construct their professional identities. In the next section I will examine the literature on nursing as a profession. As an overview it could be suggested that in relation to a technology-in-practice model much of the literature on nursing professionalization comes from what I would call an identity-in-practice model: nursing identities negotiated through practice and ordering in relation to the medical field. I argue towards the end of the chapter that although an identity in practice approach can be commended for its dynamic orientation to identity construction; it nevertheless misses the importance of technological interaction in formation of nurses' professional identity.

2.8 Nursing Professionalization

In this section I will look at material that concentrates on the professionalization of nursing, with a specific focus upon nurses' efforts towards professional practice in relation to medical professionals. I will highlight research literature from the sociology of nursing that discusses the historic tensions concerning power relations between these two professions. I will then present material that suggests that nurses have in some way found a way around these tensions by employing covert and overt forms of communication that impact upon the contextual battle for decision-making between the two professions. I will then present the work of Carmel (2003, 2006a, 2006b, 2013) on ICU nursing, which although coming from a different theoretical perspective on the importance of technology to the social arrangements in the ICU is of direct relevance to my research. The review will reflect that, as other authors have indicated, the increasing sophistication and complexity of medical technology in areas of nursing has brought about a shift in the professional status of nurses (Bull & FitzGerald, 2006; Barnard, 2002; Saba, 2001; Barnard & Gerber, 1999) co-determining both the profession of ICU nursing and nurses' relationship to the doctors.

In the sociology of nursing literature debates surrounding the status and professional position of nurses, in relation to medical practitioners, have predominantly focused on explicating differences between the two professions. These differences have largely surrounded the historic subordination of nursing expertise to the requirements of medical professionals, acknowledging without challenge the view that doctors held a monopoly of medical knowledge and expertise. May and Fleming's (1997) work in the sociology of nursing in the UK indicates that the forces of socio-legal structures, particularly the legislated attribution of expert knowledge to medical professionals, has established localised institutional power distributions. This, they suggest, is in part due to aspirations for professional control and management of health institutions dominated by medical professionals; backed up through state enshrined policy demarcating the boundaries and responsibilities of both medical and nursing practices through divergent education, training and legal charter. This divergence has historically favoured medical knowledge above nursing knowledge in the control of health practice (Davies, 1995). In recent decades, however, nursing professionalism has emerged to contest medically dominated areas of practices (Walby et al., 1994). According to Walby et al., this has been due to the shift in emphasis in health provision away from the dominance of a scientific outlook on health towards a more socially contingent notion of health and illness experience. The growth in nursing professionalisation has helped to shape this care paradigm.

One outcome has been a differentiation of the work of doctors and nurses, one concerned with diagnoses and treatment regimens and the other focused upon the care of patient throughout their treatment. In this division of labour the notion is that the professions have developed a complementarity towards the other, each having its own tasks and roles. In this context specialist areas of nursing expertise and degree accreditation, among other things, have helped nursing raise its game with regard to its hitherto subordination to medicine (Wynd, 2003). As May and Fleming suggest, the rise of nursing professionalism has in part chosen not to compete against medicine over fields of expertise but to construct a space of 'difference' from medicine. This difference is expressed in nursing theory or models that understand and constructs the patient and their illness as a medico-psychosocial phenomenon. The suggestion is that nursing outlooks come from a holistic approach to patients' illness experience (Carmel, 2006b). In this discursive construction of the patient experience nursing informs itself of its own practice activities and professional identity. The authors' place an interesting distinction/tension between what nurses ought to do (theories of nursing process) and what they really do when nurses practice the ideals of holistic care. It is suggested by the latter that through micro care interactions with patients that contingent narratives emerge which help differentiate nursing from medicine. Theses narratives, as May and Fleming (1997) state: *"reflect the creative impulse that must lie at the intellectual core of any occupational group. While medicine is able to focus on scientific understanding and technical advances as the site on which its imaginative impetus is exercised, nurses represent themselves as being in a different business*

altogether. They care about — and get attached to the patient— while doctors stay detached and seek a cure. In other words, the professional imagination provides a point of departure for the construction of a professional identity, its projection into interactions and relationships." (p.1097).

Nevertheless, May and Fleming point out that however nurses feel about their professional autonomy and domain of expertise there are macro institutional constraints which necessarily confine nursing to a subordinate role in clinical practice. Whether the tensions between the macro and micro imperatives of nursing practice exist or not they inevitably play out in the on-going empirical practice of nurses. However much the historic professional relations between nurses and doctors are sustained the emergence of a critique of this somewhat static relational model within nursing academia insists that research ought to examine actual in-situ interaction. Illuminating the contingent and contested areas of professional power; the negotiation of professional boundaries (Allen, 1997) and constructive inter-professional working (Pullon, 2008; Chaboyer & Patterson, 2001) can help researchers gain a greater understanding of how nurses and doctors interact (Stein et al., 1990). For although formal structures prevail (codifying and instituting practice boundaries) at the micro level caring for the 'whole' (social and biomedical) patient requires new ways of interacting among nurses and doctors (Allen, 1997; Svensson, 1996) which create contested points of decision-making around types of care interventions.

Exploring the supposed subordinate role of nursing to medical judgment Porter's (1991) investigation outlines the use of four discursive strategies nurses use to level out decision-making differences between nurses and doctors. These include overt/ covert and informal/ formal decisions based communication. The point made by Porter is that these strategies are used at chosen points in interactions and attest to the on-going negotiation surrounding patient-doctor-nurses interactions. Indeed, as Porter indicates (1991), contrary to "unproblematic subordination" (p.734), ward-based nurses exercised a great deal of decision-making within the medical domain through informal and covert communication strategies played out with doctors. Of course, these strategies used by nurses to participate in decision-making activity may not be sanctioned by formal professional protocol. Nevertheless, as Allen (1997) points out, they mark the 'negotiated order' between medical staff and nurses in order to manage professional boundaries and the complexity of real world patient care (Pullon, 2008; Tjora, 2000).

Whilst the 'negotiated order' goes on differences in profession status continue to mark formal divisions between nurses and doctors. The routine tasks that separate both professions at the same time confer status on the medical profession, such as doctors' control over drug prescribing and management of treatment. In many respects the division between the two professions acts in hierarchical and hegemonic ways. Hierarchical because it assembles status and power the further up the organisational ladder the individual doctor is situated. It is hegemonic because consultants' wish for authority is assured through held expectations over the rightfulness of their status. It is reproduced through active consent from junior staff and the wider organisational legitimacy of the hospital organisation; where senior medical practitioners "seek to mobilise and reproduce the active consent of others in organisations" (Currie & Brown, 2003, p.6). Yet as authors like Laclau and Mouffe (2001) show hegemony is never total and, as Currie and Brown demonstrate in their research on hospital organisation, it can be contested at the lower levels of the organisation. Thus, for instance, the status afforded to medical staff is held loosely by junior doctors in relation to specialist senior nurses where their greater experience and knowledge may blur the boundary of formalised professional activities (Carmel, 2006a; Allen, 1997).

2.9 The two Professions and the Boundaries of ICU

In the context of ICU nursing Carmel (2006a, 2006b) investigates the professional boundaries between nursing and medicine. The ICU environment is accorded a particular status in the 'subordination'/ 'competitive' debate between nursing and medicine. To paraphrase the novelist L.P. Hartley, "The ICU is a foreign country: they do things differently there", and what they do, according to Carmel, is work on informally blurring the boundaries between medical and nursing practices, routines and responsibility. The novelty of Carmel's analysis is to explain sociologically the reasons for the idiosyncratic activities of the ICU. In his ethnography he noticed that differences in professional activities were obscured in order to enhance the ethos of teamwork between staff in the ICU. By enhancing collective commitment to the team and care activities this informal strategy reinforces the boundary between ICU and other areas of the hospital which are likely to put pressure on the resources available to the ICU. As Carmel (2006a) states, "an occupational division of labour is rhetorically and practically obscured, while an organisational division is rhetorically and practically reinforced" (p.155). Rather than perceiving competition or indeed covert forms of resistance to medical authority on the part of nurses, the research evidences high levels of incorporation between the two professions. This integration works along two separate boundary fields for a related purpose. By practically obscuring the formal nurse-doctor profession boundary establishes a "joint ICU 'project'" (Carmel, 2006a, p.155), directing the efforts of staff toward enforcing the boundary between the ICU and other medically allied areas of the hospital.

This alliance within the ICU, according to Carmel, comes about through the situated nature of working in the ICU. In the first instance, staff generally put in long shift hours in intensive care. The other component of this team knitted-ness is the environment of the ICU. Compared to other areas of the hospital, it is, by its nature, isolated within the hospital; its physical boundaries formally protected from intrusion from unwanted agents (biological and social) that could seriously undermine the wellbeing of patients (Carmel, 2006b). Each of these components serves to strengthen internal ties whilst emphasising external pressures.

According to Carmel's study, the close knitted-ness of the ICU team requires a certain amount of acquiescence on the part of both doctor/consultants and nurses. For example, informally consultants accept and indeed encourage the input in decision-making by senior nursing staff. This is seen as a pay-off, amongst other things, for the limited time consultants spend with each patient. Moreover, consultants might enrol the expertise of senior nurses as evidence for their own decision-making when confronted by differences in medical opinion. On the other hand, nurses can be interrupted in their care practice by consultants' difference of opinion over medical protocols. Carmel shows that in these circumstances nurses temper their judgement over medical staff, allowing for differences whilst buying into the importance of professional judgement. Acceptance and forbearance of these varying opinions, and tacitly working round them, is one way that nurses show respect for the seniority of doctors. Similarly, consultants take the skills and knowledge of nurses seriously with an ethos of give-and-take benefiting all collaborating work colleagues in the ICU. Acknowledging these differences between consultants and senior nurses, Carmel highlights the subtle on-going interactions that constitute the blurring of professional boundaries in his analysis. Interactions that practicably get the job of ICU care done. At another boundary level, Carmel examines how teamwork and the ICU project buffers pressure from external hospital areas allied to the ICU, such as emergency and surgery departments. These areas are interconnected with the ICU. However, the author discloses how senior staff in the ICU mediate boundary interactions, usually entailing patient transfers- in order to reinforce the status of the ICU. As a result, upholding the remit of the ICU domain acts to differentiate intensive care from other areas of the hospital in terms of the quality of care it delivers. Indeed, both internally and externally the ICU accomplishes a notion of superiority over other hospital wards. As an outcome, ICU nurses are given and give themselves higher status in comparison with general nurses. As Carmel states (2006a), "a rhetorical contrast is drawn between the nursing 'expertise' within the ICU and the "'chaos' outside it" (p.170).

Carmel's study extends the research field and goes some way towards shifting the macro debate in favour of understanding the content of both professions, not by taking for granted the division of labour but by exploring their real world relations. He helpfully develops the micro interactions, at least in the arena of ICU, and in doing so suggests that the everyday activities of the two professions remains an web of negotiations all towards a collaborative environment that sustains the ICU project. In particular, in its exploration of the in-situ interactions, Carmel's insightful paper theorises the ICU project within the accomplishments of boundary work by staff, both in the porous boundary of internal labour divisions and in the horizontal boundary of organisational divisions between ICU and external players.

Carmel's study recognises the teamwork that holds the negotiated order within the ICU - with the blurring of roles and tasks between medical staff and nurses (Carmel, 2006b) as an essential strategy to preserve the ICU project. The research also discloses the reinforcement of environmental boundaries between the ICU and other sites in the hospital, again as boundary strategy in order to protect medical specialism. However, Carmel neglects to focus on the importance of technology in the mediation of nursing and medical staff within the ICU and across the ICU boundary. He mentions in passing the situatedness of technology and its importance to ICU care, but makes no analytical advances in how the materiality of technical objects within the ICU play an important part in mediating the nurse-doctor interaction. For instance, he talks about consultants relying of the expertise of nurses but does not draw out how expertise might be constructed by nurses in their constant interaction with the technology within the ICU. Technology plays a neutral role in Carmel's ICU world, and in this normative sociological account, the ontological emphasis is upon human actors alone. By taking up this sociological position the world of objects is foreclosed from analysis. Thus, the analysis misses out the importance of the ICU environment, its technology, and its place in the interactions of nurses and doctors within and without.

Both in his PhD thesis (Carmel, 2003) and later work (Carmel, 2013) Carmel acknowledges the neutrality of technological actors in human practices as a feature of his preferred theoretical approach - 'practice theory'. In this approach material artefacts do mediate human activity as unproblematic ordered forms, however the ontological force and instigation of any social practices lies with humans alone (Schatzki, 2001). Although those who advocate an actor-network approach would describe themselves as 'practice theorists', there are some practice theorists who find the agency of artefacts and the force of networks as a configuring device for human activity somewhat unwarranted in empirical research (Carmel, 2013; Schatzki, 2001). As a riposte to the implied unwarrantability of actor-network theory it might be intimated that practice theory, as espoused through Carmel's research, refuses to engage with the

full implications of the materiality of the world. The upshot is that constructed themes, such as nurse-doctor 'incorporation', are never entirely explained in the context of the ICU. Carmel's studies (Carmel, 2003, 2006b, 2013) do acknowledge the expertise of ICU nursing. However, he does not show us how professional expertise is manifested in the interactional moment, nor through what actions involving technology are demonstrations of expertise accomplished.

In the findings, presented later, I will describe nurses' interactions not only with doctors but also with the objects in the network of the ICU. By taking this journey I will show that when nursing expertise, professionalism, and identity is existentially linked to their work with technological objects these nursing attributes, such as 'expertise', can at times falter, strengthen and indeed shift into other forms. Thus in their engagement with technology, the nurse can present as 'scientist', as technician, as 'little doctor', as 'Angel' (Ferns & Chojnacka, 2005). I am interested in the way that nurses incorporate with technological and human networks in their engagement with the social arrangements in the ICU: with doctors, consultants and patients, their relatives and other technological objects. This approach to the study of medical technology in action echoes the recommendation put forward in Timmermans and Berg's (2003) review of technology research in the medical sociology. They petition to bring current theories from science and technology studies [STS] into the world of medical technology research, arguing that these ideas, particularly actor-network theory, can help illuminate the emergent context of social interactions by acknowledging the ontological importance of technology in co-configuring the socio-technical activities of actors. As Timmermans and Berg (2003) state: *"Technology is viewed as one actor among many in changing configurations of social and technical elements (Law and Hassard, 1999) (reference original to quote)… [I]n this approach…technologies are embedded in relations of other tools, practices, groups, professionals, and patients and it is through their location in these heterogeneous networks that treatment, or any other action, is possible in health care."* (p.104)

My criticism over the omission of a thoroughgoing discussion of technology in the mediation of nursing identity and practice extends to all of the studies discussed above. Perhaps it is the ubiquity of technology in ICU which makes it invisible to a great deal of ICU nursing research. It becomes transparent like glass, but even the thinnest of glass refracts the object that is viewed through it. So it is with nursing in the ICU, its activities and its interactions must be analysed in relation to the technological objects that make it possible in the first place. Indeed as Barnard and Gerber (1999) indicate the accent on professionalism in modern nursing in many respects hangs on the uptake of technological advances in medicine. For technological involvement in nursing practice is persuasive in articulating professional status, as Barnard and Gerber (1999) state in their analysis of nurses' experience with technology: *"The outcome of the experience is understood to be increasing inclusion in decision-making, autonomous practice, professional consultancy and collegiality. Technology is experienced to be a phenomenon capable of elevating nurses from their role of assistant to the doctor."* (p.161). Decision-making, professional consultancy and collegiality are all components of nurse-doctor relations that run through Carmel's study which, as Barnard and Gerber insightfully acknowledge, are mediated largely by the contextual features of technology in medical environments. Unfortunately in Carmel's study we encounter a technological blind spot in the analysis. We are denied insight into the extent that the technological environment mediates social interactions in the ICU; how relations of humans and objects interplay to establish the negotiated order.

In his second paper on the ICU Carmel (2006b) extends his analysis of the incorporated work of doctors and nurses. Here he insists that academic nursing theories that articulate the holistic view of, "nursing towards the patient as 'relational subject' " (p.2086) and the differentiation of nursing in relation to medicine both contradict the actual on-going practice of nurses, particularly in the ICU. On the latter point, ICU nursing in practice does not necessarily eschew the objectifying nature of medical science. In many respects the nature of ICU demands that they appropriate medical knowledge and skills in order to service the sometimes bio-physiological complexity of the patient's illness condition. Similarly, Carmel contends that the holistic theory can perhaps only succeed when the patient can be related to as a social entity, whereas when nurses are involved for much of their practice with sedated patients the possibility of affording a subjective care is impossible. Instead Carmel (2006b) suggests that rather than the nurse-patient dyad ICU nurses should look towards fostering a, "nurse-patient's relative" relationship (p.2080). Here the holist approach is enacted through ensuring the patient's social context is maintained.

Carmel's argument that standard nursing theory does not capture fully the boundary of ICU nursing is persuasive. However, Carmel's mode of analysis of these fundamental socio-technical relations may be contested. This study, like the ones previously discussed, again neglects to involve in any depth the socio-technical context of nurses' interactions with other medical personnel, with patients or their relatives. Carmel is right to suggest that at any given moment ICU staff might portray themselves as the acme of holistic caring; while in another they medicalised the patient out of social existence, relying instead on their knowledge of physiological science to configure the patient in relation to their illness condition. My focus, although it touches upon many of the themes raised by Carmel, by contrast seeks to find explanation for the changing practices of ICU nurses in the complexity of shifting network

arrangements involving human and non-human, technological as well as social actors. Following ANT, I will explore nurses as creative engineers of heterogeneous elements that circulate within the ICU environment. How they do this and how they are able to configure both materials and symbols and other actors as elements in their practice will be the focus of my investigation of nurses' understand and use of technology in the ICU.

2.10 Nursing Identity

In Barnard and Gerber's (1999) work on surgical nursing and technology they demonstrate that nursing professionalism can hinge on the appropriation of forms of technology as nurse technology. By taking hold of the technological means of health production nurses are able to promote a material and symbolic component of their professional identity, and indeed extend nursing expertise into areas hitherto confined as medical knowledge and activity (Barnard, 2002; Barnard & Sandelowski, 2001; Barnard & Gerber, 1999). In terms of actor-network analysis, it could be said the nurses that Barnard and Gerber describe are appropriating the technology to promote their professional standing. Building networks of new technological configurations would certainly encapsulate their enterprise as heterogeneous engineering; bringing to bear an assembly of elements and over time stabilising them to progress their interests. Through this acquisition of technological skill and knowledge they move beyond the expected boundaries of nursing work and construct new professional identities.

I am interested here in the potential for nurses, in their interactions with the technological environment, to form an array of identities. Lehoux et al. (2008) explore this point when examining the displacement of hospital dialysis technology into the community. Although the authors acknowledge the reconfiguration of identity in relation to the displacement of technology, their analysis suggests this occurred only once, as health staff move out of the clinical environment into the community. The indication is that professional identity will stabilise after a period of settlement in the new context. Critically, although I agree with Lehoux et al. on the matter of identity reconfiguration in light of radical network transition, I would suggest that identities can also be capricious in the context of stable socio-technical network interactions.

As an accompaniment to the idea of nurses' identity construction through interaction with technology, a recent study by Ulucanlar et al., (2013) focuses on the identity given to technology in healthcare settings. These 'technology identities' come from the human necessity to make objects, including technology, socially meaningful. Importantly, the authors indicate that technology identities are also formed with respect to, "…the nature of the technology itself and its material properties" (Ulucanlar et al. 2013, p.103). Ulucanlar et al. suggest the construction of technology identities, mediated by the healthcare practice environment, is a clue as to how technology adoption is achieved. Although the metaphor of technology identities is described as an accomplishment akin to human identity construction, the analysis fails to reveal any reciprocal relationship where clinicians' identities are formed in their interplay with the technology. I will note in passing that the construction of positive nursing identities might also be a deciding factor in the adoption of technology in practice.

In reviewing the literature I have shown that technology has increasingly become part of the caring world of nurses, particularly within ICU nursing. However, if we draw on the technology-in-practice model as described by Timmermans and Berg (2003) we find that very few writers and researchers on nursing and technology have fully worked through the implications of technology-in-practice in relation to their research on medical technology. It is my aim with this study to work within Timmermans and Berg's agenda to explore ICU nurses' practical dealings with technology; to engage and be open to the ebb and flow of network interactions that make up the world of ICU nursing.

3.0 METHODOLOGY

In this section, I will first present the methodological grounds that informed my approach to the research study. I will then go on to describe the research process including recruitment strategy, methods selection and data gathering. I will also discuss some of the issues that arise in using these methods. Following on from this I will give an overview of how the analysis was conducted, finishing with a discussion on the ethical matters involved in conducting research with nurses in a health setting.

3.1 Epistemological Assumptions

To address the questions of nurses' situated interpretation of technology, the study will adopt an interpretive approach. The interpretive paradigm in social science research seeks to discern how individuals interpret and give meaning to the social world and indeed produce and constitute the context of their social existence. In its efforts to gather an understanding of how people constitute or construct social 'reality', interpretivism will focus on, among other possible phenomenon, the meaningful talk and context based practices of individuals. As Mason (2002) writes, interpretivism broadly considered is, "concerned with how the social world is interpreted, understood, experienced or constituted" (p.3) by individuals and groups who inhabit it.

Allied to this interpretivist stance, the study also considers its methodological position to be naturalistic. In contrast to positivistic research efforts to gather evidence from pre-fabricated experimental tests; where 'laws' of cause and effect are explained through the analysis of discreet variables is a common feature (Silverman, 2004; Hammersley & Atkinson, 2003), the data will be gathered from interviews and observations derived from researcher immersion in 'autonomously,' (i.e. non-experimental) 'naturally' occurring social practices (Mason, 2002). In contrast to positivism, the turn to naturalistic research indicates a concern for, "studying the meanings that arise in natural settings" (Silverman, 2004, p.7). In this sense context is both central and epiphenomenal to meaning making practices. On the one hand, it is epiphenomenal in that it forms the background or context for people's interpretation of, for instance, technological artefacts in medical environments. On the other hand, the context is itself constituted by the interactional meaning making of individuals. The exigencies of this, as Mason (2002) indicates, is that the social world can present as a complex and multi-layered reality. The interpretivist/naturalistic approach outlined above carry a number of social/philosophical assumptions that guided both the data gathering through interviews and observations, and informed the analysis. It is assumed that:

- Not only do individuals (nurses) describe the world they live and work in, but also they are involved in constructing this world through the meanings they give to the 'world'; in this case, the ICU world.

- Thus, in their meaning making, nurses are at 'work' constructing, through interpretive means, the technological objects within their environment. But also, following ANT, the understanding and meaning nurses' place on the world comes as a result of their relationality to the world of the ICU and the objects therein.

- As a point of reflexivity, the methodological stance presented here insists that whilst people are in the process of both experiencing and socially constructing the technology, simultaneously they are shaping their world through the technology.

- Importantly, both the social and technological are contingent and relational: that is to say, each factor is 'understood' at the moment of their interaction. Meaning, in a sense, arises as a product of the context; expressed differently it is a concern for the, "the situated rationality of action" (Murphy & Dingwall, 2007, p.2224).

- There may not be congruence between what people say and what they do. However, both activities are also invested with rationality: peoples' actions have meaning in context, making them understood (Miller & Glassner, 2004, p131-148).

To this set of assumptions concerning the epistemological basis for nurses' account, I wish to add that each account, although the experiential summations of individuals, also contains the material and resources of wider discursive patterns; namely the culture of the ICU. This is to say, nurses' accounts are the unit of analysis. However, I wish to suggest that this analytical stance also allows interpretive insight into the socio-cultural milieu of the ICU department. The following section describes the approach to informant recruitment, sampling, data gathering, data analysis, and ethical issues.

3.2 Accessing the field of ICU Nursing

The research fieldwork study took place at in a large teaching hospital in the East Midlands. In order to gain access, in the first instance, I contacted senior staff through an introductory email to senior consultant practitioners at the East Midlands Critical Care Network. The network operates to bring together practitioners, patient-stakeholders, and educationalists involved in critical care in the East Midlands. Through numerous email exchanges with senior medical staff, I was advised to contact the consultant nurse at the hospital. After an email requesting possible access to the ICU, I was invited to meet with the nurse consultant in charge of ICU services. Our initial meeting had been very positive, with regard to potential access. At the meeting, which I had prepared for, we discussed my plan for data gathering; the number of nurses I would interview and the form the observations would take; as well as the likely timetable for data gathering. I left the meeting with a positive feeling of support from the consultant nurse. Hammersley and Atkinson (2003) write about gatekeepers and their importance to successful access. They mention that access permissions come in different forms, and it might be necessary to gather them all to ensure unhindered access. One has to talk of access and permission in the plural. To do any research, as I found out, in the UK National Health Service, requires the researcher to seek multiple permissions both informal and formal. Furthermore, in real world research informal permission can turn to formal request and vice versa. In addition, different types of permission

processes can run in parallel or consecutively. Each of these points of access requires negotiation, one moment with large bureaucracies, and in another face-to-face personal engagement with stakeholders and gatekeepers. I will briefly deal with these matters of access in turn. The nursing consultant would become the key gatekeeper for the practical side of access; ensuring that senior staff were aware of my arrival on the unit and what I needed to achieve during my period of fieldwork; smoothing the way in terms of time and space for me to interview ICU nursing staff. Her enthusiasm for my research remained constant through my fieldwork period, ensuring that I would be extended all possible access to the ward environment. Indeed, much of the later access requests, after receiving local Research & Development (R&D) approval and national NHS ethics approval, became informal permissions given by ICU staff as part of their daily running of the ward. Nevertheless, as part of proper research conduct, I felt that I should continue to ask for permission to enter the unit whenever I visited. This I felt reflected appropriate standards of research conduct.

Returning to the first meeting with the nurse consultant, I was asked to write up a brief proposal of the research. This would be presented to clinicians at the Hospital's critical care network meeting. After the proposal was considered, it was accepted in principle that the research could go ahead; after all formal channels of research approval had been met. What followed was six months of Integrated Research Application System (IRAS) applications along with local R&D approval. After all formal gate keeping processes had been satisfied, and ethics approval granted, I spoke with the consultant nurse, and arranged to meet again to plan my introduction to the ICU field. We met and discussed a timetable for the fieldwork. The first phases involved timetabling five blocks of time for observations. After this period, as the observations continued, I would start the second phases of recruiting individual nurses for interview. In order to do this, as part of the IRAS process, I had devised information sheets and consent forms for both the observations and interviews. As part of my initial introduction to staff, I supplied the consultant nurse with copies of the letter of invite and information sheets for interview recruitment (see appendices A, B and C) and asked that they be placed in the pigeonholes of all ICU nursing staff. The information sheets invited individuals for interview with appropriate information as to the purpose of the research, details of informed consent and expected participation commitments (i.e. interview time and place). I also asked consultant nurse to announce my research programme prior to my arrival on the ICU, as part of scheduled staff meetings.

It was planned that I would initially engage with the unit's staff and environment by starting my observation work. This approach gave me the opportunity to familiarise myself with the environment of ICU nursing, (a wholly new experience for me!) and to introduce myself to the ever-changing rota of nursing staff who work on the unit, before recruiting nurses for interview. During the initial period of observations, I became familiar with some of the nurses. This gave me the opportunity to discuss my research with them, and to ask if they would be willing to be interviewed. As it turned out, with the senior nurse's encouragement, gathering candidates for interviews was relatively straightforward. Due in part by nurses being intrigued with the subject areas of science and technology studies and how ICU nurses' involvement with technology might figure in the scheme of things. In addition, the ICU views itself as a research active unit. Although, most of the research conducted on the ICU comprises clinical trials, staff were familiar with research activity and their occasional involvement in it. With regard to observation periods, I would visit when professionals deemed it appropriate. As it happened, staff were happy for me to observe their practice, though the information sheet indicated that anyone not wishing to be observed at close quarters could withdraw their permission. This approach to observing the ICU and nurses was in tune with patient confidentiality- no observations were carried out when bed screens were drawn; as well as recognition of and sensitivity to the changing circumstances of ICUs. These last two points being important considerations in research conduct. Throughout the data-gathering period, I liaised with ICU staff to ensure that all participating nurses were kept informed of the research process.

3.3 Participant Recruitment and Interview Strategy

Participants were recruited from staff working in ICU environments. For the purposes of balanced sampling, the research design used strategies influenced by purposive sampling strategies (Mason, 2002). This ensured that the social make-up of respondents reflected the overall balance of nurses in the ICU, which was approximately 80 members at the time of the fieldwork and interview period. The use of purposive sample also ensured that a representative mix of all potential informant was achieved (Teddlie & Yu, 2007). In all, 20 in-depth interviews were conducted as part of this research study. The interviewees comprised of six male and fourteen female members of the nursing staff, this ratio reflected the wider sex mix among all nursing staff in the OCU. In addition, I also strived to mix the age and experience of staff by interviewing junior staff and students along with senior and older ICU staff. Although the task in purposively selecting particular interviewees was to get as broad a perspective as possible on technology, the selection process had also an element of pragmatic convenience and 'snowballing' (Teddlie & Yu, 2007). Not all staff wanted to be interviewed. However, I attempted to seek as wide a range of views from across the

staff group as possible, while acknowledging the notion that my sampling did rely on the convenience of selecting staff members who were happy to be interview.

The interviews were conducted using a semi-structured interview schedule (see appendix D), the purpose of which allowed the research to explore set themes from the nursing and technology literature. At the same time, respondents could elaborate upon details they felt were important to the topic area. Employing this interview technique ensured that interviewees' views were freely expressed without constraint from the thematic schedule. I have already stated that the overall investigation of nurses and technology would be driven, theoretically, by insights from actor-network theory. One issue raised when taking this position, was how to *operationalise* these ideas into questions understandable to participants (Mason, 2002). It was easier, in fact, for nurses to talk about how technology determines their routines and tasks- more difficult to talk about networks and heterogeneous engineering. Similarly, nurses grasped the idea that they might shape or use the technology in ways, which were different from its intended purpose. For example, I recall one nurse talking about using glue from a different pack in order to secure a patient's nasal gastric tube because the fixative that came with the tube was inadequate.

The solution to the problem of '*operationalising*' (Murphy, 2003; Mason, 2002) ANT ideas, was to let the nurses' emic understanding be the resource for exploring network relationality. So, for example when nurses mentioned the terms term 'chasing numbers', or 'looking after organs' I would follow up these, "significant indigenous [emic] categories" (Hammersley & Atkinson, 2003, p.194) by exploring the potential for them to reveal network building strategies on the part of nurses. However, the task of 'operationalising' concepts in the cut and thrust of interviewing participants at times lead to dead-end questioning, breaking the flow of the conversation. In contrast, Mason (2002) suggests rather than thrusting dry and complex concepts into the interview, there is more to be gained, in terms of gathering meaningful data, by merging conceptual ideas into questions. The focus should be more on, "lived experiences than hypothetical…abstract concepts" (Mason, 2002, p.68). Participants should be empowered to explore actions familiar to their daily activity, in a meaningful way. In attempting to provide the space for nurse interviewees to do this, I was required to undertake a great deal of analytical and reflective processing while conducting the interviews.

A further point should be made on the issue of the status of the data derived from the interviews. As the argument goes, in qualitative research, material derived from interviews is only a construct managed between the interviewee and interviewer. The problem arises as to whether this evidence should be used outside the constructed conversation of interviews (Miller & Glassner, 2004; Silverman, 2004). Commentators on qualitative research suggest that the contextual limits of interview data should be acknowledged. While at the same time, this should not delimit the fact that interview participants can provide information about the 'reality' outside the interview context (Miller & Glassner, 2004). Indeed, if the place of the interview is kept within the overall research context, e.g. the ICU, it can become a resource to engage with accounts of reality. For example, the interviews conducted for this study, occurred in spaces familiar to nurses as part of their daily activities. One of the rooms used had a new dialysis machine present, which nurses used to refer to particular interactions with technology.

Having discussed some of the issues around interviewing as a strategy for data gathering, I will now return to the practical matters involved in interviewing nurses for this study. All interviews conducted for the study lasted approximately one hour. The majority of the interviews were conducted within the confines of the ICU; either in staff meeting rooms or offices set apart from the main unit. By arrangement, interviewees preferred to be interviewed prior to, or just after their shift. A handful of interviews were conducted on shift. On the occasions nurses were interviewed at work, the opportunity arose when senior staff felt the unit was settled enough to free staff from duty to participate in an interview. At the interview, participating nurse were given a further hard copy of the information sheet. In line with appropriate interview technique, I further outlined the contents of the information sheet, and addressed any questions that participants had with regard to the research aims. They were informed that the interview would be digitally recorded; that the recordings would be transcribed and stored in a password-protected computer and only myself and supervisors would have access the raw interview data. After this introduction, which was reiterated with all interviewees, participants were asked to sign a consent form. At this point interviewees were given a ten-pound gift voucher as a token of appreciation for specifically taking part in the interview.

There is much debate surrounding rewarding people for research participation. On the one hand is the view that offering rewards acts as a form of coercion, particularly within disadvantaged communities. On this point, Head (2009) notes that monetary incentives, even relatively small amounts, may be too lucrative to refuse. However, in recent times, the ethical stance appears to be that research studies should reward people for their time, effort and the local knowledge they bring to illuminate the research findings.

3.4 Observing the ICU

Along with interviewing nurses, I conducted observational studies in the intensive care unit. Observational studies under the mantel of ethnography has a distinguished place in health research, among which Goffman's study of mental health (Goffman, 1970) and Glaser and Strauss' (1964) study on hospital deaths are exemplars. This particular approach of observational research, throws up a number of ethical issues, which are explained below. In this study, the purpose of the observational work will be to acknowledge the actual interaction of the nurses with the technological environment of intensive care nursing. The thinking being that this supplementary data gathering method arises in the researcher's belief that individuals' interaction with both the environment and the objects within it takes place at an intuitive level. Moreover, at this level much can be understood from observing how nurses might make sense of technology. Indeed, for some nurses, their long-term involvement with the health technology at their disposal, can result in taken-for-granted the resources and tools they use as part of their nursing role. By observing nurses' interaction with technology and indeed other nurses, this phase of the research helped inform the interview schedule by assisting respondent to elaborate and clarify their actions. The observations and interviews were conducted in phases. Initially I conducted observations, and then started interviewing while carrying on with the observations. This enabled an iterative approach (Mason, 2002) where observation would inform interview content, by way of follow-up questions on the observations. This iterative approach of observing nurse/technology interaction on the unit and then later discussing the activity during interview, helped in firming up some of the themes I explore in the section on findings.

With regard to the tenets of qualitative research, adopting this iterative approach to the interviews and observations also served to provide triangulation in the data gathering, whereby one source of information is tested against another in order to assert the veracity of the phenomenon under investigation (Hammersley & Atkinson, 2003; Fetterman, 1998). This approach involves the triangulation of methods. However, there is other way to perform triangulation in research (Mason, 2002). The strategy of triangulation was used during interviews when looking at the thematic contents of nurses' accounts in the initial interviews to verify particular phenomena in subsequent interviews. So for example, when one nurse used the term 'chasing numbers' to express an aspect of patient care, I was interested to follow this theme up with other interviewees to understand if this was a shared phenomenon in the culture of the ICU. Similarly, when another nurse talked about, "looking after organs" this interesting conceptualisation of the patient under technology, directed me to explore the resonance of this idea for other nurses. This approach suggests a triangulation of the data for theme building.

The use of triangulation in qualitative research, as a marker for validity and reliability is problematic. For some commentators, such as Blaikie (1991), Seale (1999) and Mason (2002), triangulation in qualitative research has adopted in part the quasi-robustness usually associated with positivist research. Tied, as this research paradigm is, to the ontology of stable empirical objects any, "triangulation used in this way assumes a single fixed reality that can be known objectively through the use of multiple methods of social research" (Seale, 1999, p.473). In qualitative research, it is implied that multiple methods, used to reveal the same phenomena, will give a more exact understanding of the entity under investigation. However, as Mason (2002) indicates, when we take on board the precepts of qualitative enquiry, we are met with the understanding that different methods are, "likely to throw light onto different social or ontological phenomena" (Mason, 2002, p.190). As a solution out of this- one I would agree with- is not to consider triangulation as a means of empirical verification, but as a way to enrich the description and understanding of the phenomena. Thus, observing ICU nurses and then asking them about their actions during interviews allowed me to explore the phenomena in a more rounded way. If this also throws up contradictions, then so be it. As Mason (2002) further indicates, taking this approach to multi-methods research might enhance validity as it shows that, "social phenomena are a little more than one-dimensional" (p.190).

The overall fieldwork was conducted over approximately four months between October 2010 and February 2011. Within that time, I spent forty hours on observation. A large majority of the observational work took place on the Adult Intensive Care Unit at the teaching hospital. Observations were carried out during morning and afternoon/evening shifts in four-hour sessions. As I describe in the ethnography section, this time period was optimal. It allowed me to target specific activities I wished to observe, without being overly bombarded by periods of extended observation. Following each observation period, I set aside an hour immediately following to expand on the notes I took while in the field. This space, out with the ICU, was an opportunity for reflection, to gather my thoughts, and make tentative connections among the various discrete phenomena I witnessed. Programming the observation work for morning and afternoon sessions gave the opportunity to observe nursing teams across their working day. As well as the dayshift, the observations encompass afternoon-evening shifts. On reflection, both shifts offered many opportunities to observe various routine activities, including, preparing patients for transport to the MRI scan department; portable x-rays on the ward and setting up of dialysis machines. This was also a time to observe nurses interacting with patients' relatives, of which I will talk more in the findings section.

3.5 Ethical Concerns

The data gathering methods outlined above highlight a number of ethical issues. In the first instance, interviewing nursing staff required the study to seek informed consent for the actual interview and the use of subsequent data. To mediate individual consent, all interviewees were given an information sheet outlining the nature and purpose of the study prior to interview. The information covered the responsibilities of the research to ensure that any potential risks in terms of disclosure and confidentiality were minimised. As part of the researcher's responsibility, the conduct of interviews will minimise issues of personal and psychological harm that might ensue, (Murphy & Dingwall, 2007). This safeguard will extend to any subsequent report of findings. Interviewees were clearly informed that they could withdraw from the study at any time, and any information that they had given would be removed from the study. On the matter of research data management, all recordings and transcripts are held on a password-protected computer. The only personnel with access to the raw data throughout the study have been the PhD student and two immediate supervisors.

The ethnographic/observation component of the research involved further issues that need addressing. Although consent was given by the nurse consultant to observe the ICU environment, consent to observe nurses going about the duties required individual's consent. This was negotiated with each member of staff on an ongoing basis. So, it would happen that on one shift a nurse would consent to me closely observing her/him, and on another shift, the same nurse might for good reasons, decide to withdraw that consent. This of course was respected. Fortunately, this seldom happened and when it did occur, it was usually for the patient's best interests. Similarly, the issue of visiting professionals to the unit had to be negotiated. Although the observation focus was on the nurse, to counteract issues of 'over-observance' a clearly defined framework of observational goals were devised and agreed between management and researcher (Murphy & Dingwall, 2007). It was explained to other professionals in proximity to the observation that the focus and limits of the observation were on the nurse's interactions with the technology. As the period of observation went on over the weeks and months, any issues regarding potential over-observance were dealt with through informal conversations with all involved at the point of interaction.

All of the above ethical considerations were extended to the patients receiving care. However, the nurse-patient interaction brought further ethical considerations. Where I could explain and inform visiting professionals of my purpose in observing the interaction, for sedated patients this was impossible. At these moments, I relied both on my own research concerns to keep these observation periods to a minimum, and to only observe and record interaction in line with the research aims. No details were recorded with regard to the physical or biographical features of the patient. With regard to visiting relatives, when appropriate, I informed them that I was conducting observation research, but at no point was I recording details of their loved-one. All of these ethical considerations were addressed and accepted by the NHS research ethics committee (IRAS) and the local research and development department based at the hospital, which gave the research study a favourable outcome and subsequently gave permission for the research to be carried out.

3.6 Analysis of the data

All interviews were recorded using a digital recorder and transcribed for analysis. The actual analysis commenced shortly after the first interviews. This allowed me to reflect upon the content of the interviews and develop ideas and lines of enquiry in subsequent interviews. Similarly, the field notes were transcribed and further annotated. Here again, points of interest in the observations, were developed as the observation periods continued. The period of in-depth analysis was conducted once all the fieldwork was finished. Procedurally, the transcripts where uploaded on to Nvivo software for more formal analysis. In the first instance transcripts were read in their entirety, and notes were made regarding possible thematic codes. At this stage, any discrepancies in the interviews were corrected. For example, if a particular section did not make sense on the page, I referred back to the original recording to verify the meanings expressed at the time of the interview. At these points, I might notice the way interviewees expressed their views, i.e. using sarcasms, humour, or indications of uncertainty. Using these vehicles of expression, I was able to clarify the possible meanings people wanted to convey. There is much that can be achieved in following processes in order to prepare the data for analysis. However, there comes a point when the analytical imagination has to enter the scene and lend a hand. To get to the stage where I could scrutinise the data for initial codes required extensive immersion across all the components of the research. Firstly, it starts, I believe, with understanding the literature. For me this meant reading extensively in the field of ANT, as well as across the large amounts of science, technology and society literature. The point is to reach familiarity with the way other researchers using ANT have used the theoretical insights and concepts.

As I moved through the transcripts, I was not reading these texts for the first time; I was not meeting this world through these texts. Instead, they worked in a way to remind me of the ICU world I had recently left. Reading

the transcripts reconnected me to the observations and interviews with real nurses and my efforts at the time of the fieldwork to piece all these discreet packets of information together to understand the whole or at least part of the whole, in order to construct a convincing story of nurses and their understanding of technology. Returning to the first phase of the analysis, each interview transcript was coded into thematic nodes using the Nvivo software. These codes/nodes were not constructed prior to the analysis, but 'emerged' from carrying out the coding and guided by reflexive engagement with particular theoretical perspectives. At this stage, some ninety nodes were devised, each one containing discrete passages of interview material. After all the interviews had been coded, a period of reflection and inspection of the codes took place. Interpretation of the data is always on going. However, at this stage, after scrutinising the codes, an involved and deeper interpretation was required to condense the disparate collections of codes/nodes down into workable analytical categories. As an interpretive tool I used standard theoretical insights around 'technological dependency' and 'technological shaping'. For example, in the second phase of analysis a number of first level codes (and their content of interview extracts) indicated that 'balanced numbers' was an indicator of patient stability. It seemed that in caring for patients, nurses depended on a steady and accurate flow of numeric information. Thus, 'balancing numbers' emerged as a substantive theme for nurses' dependency on technology. This approach to the data was also carried out on codes/nodes that indicated nurses were also shaping their use of technology.

At this point in the analysis, it would have been straightforward to report that some nurses are dependent on technologies, while others shape the use of technology, thus reflecting two classic positions in the science, technology, and society literature. However, reflecting on the real world of the ICU, by looking back on thoughts I jotted down in my field notes; it was evident that matters were a little more fluid and dynamic. At one moment nurses appeared to be dependent on the medical technology to provide care, then at other points the data suggested that they were using technology in order to achieve particular social aims. I wanted in some way to capture the sense of shifting relationality between nurses and technology. It was at this point I turned to ANT as an analytical lens with which to interrogate the data further. With the conceptual tools of ANT, I came to the interpretive position that these points in nurses' accounts, which highlighted both dependency and social shaping of technology, were the effects or outcomes of socio-technical network configurations. For example, as I show in the findings, I interpret the claim "looking after organs" as an effect of nurses' dependency on knowledge/information coming from the various specialist technologies developed for specific organ function. These medical devices, as information providers, become an *obligatory point passage*, in ANT terms (Callon, 1986b), influencing not only the nurse's interaction with patients but also, in some measure, determining the discursive formation around ICU care, i.e. not looking after patients but looking after organs.

In the final phase of data analysis, I returned to the analytical themes I had constructed from the data, and explored them further using the conceptual perspectives of ANT. This helped open up the data to a more fluid interpretation. There exists in the findings indeterminacy in nurses' actions around technology, keeping the possibilities open for change, rupture and reversal. However, I believe this approach gets nearer to reflecting the nuances inherent in nurses' understanding and interaction with ICU technology. There was no privileged position given to the observational interpretation of the research field. The insights gained from the field notes were equal to other meaning-making systems employed by participants. In the same way, analysis did not attempt to force agreement between observation and interviews with staff. Both data fields may at certain points converge in the interpretation of the situation and at other times diverge. This analytical commitment imposes certain constraints on the notion of triangulation of data gathering in order to strengthen a principled commitment to revealing a plurality of meanings, and experiences of nurses and their work involving health technology.

The observational data has been used, largely, to describe the setting and to highlight features of the ICU environments and the people and technological artefacts that inhabit the space, thus it owes more to the tenets of descriptive *ethnography* (Hammersley & Atkinson, 2003). Indeed, much of the groundwork that informed the content and questions in the interviews came from the observation made on the unit. It might be considered as a form of triangulation, but as Mason (Mason, 2002) has argued, it should perhaps not be taken in the 'realist' sense (see discussion above), but as an aid to clarify the meanings inherent in particular social phenomena, to reach a more rounded understanding and explanation of human technology interaction.

2.7 Emerging methodological issues

While I am discussing methodological issues, I wish to point out that by undertaking the principles of ANT research, to follow the actors, there is a thread of analysis and discussion throughout the findings sections. It has remained an issue for me to adhere to positivistic precepts of thesis presentation while engaging with Actor-network theory. That is, to present the findings/data section separate from any discussion or analysis (Firestone, 1987; Eisner, 1981). In standard presentation the positivist sleight-of-hand works by casting the empirical material as objective brute-data, free from the subjective interpretation (and bias) of the researcher-observer; who at a later point in time

during discussion reveals post-hoc, the objective meaning inherent in the data (Mitev, 2009). For me, two issues arise from what Firestone describes as the 'objectivist rhetoric' of positivist presentation (1987, p.17). One concerns ANT and my attempt to work within this approach, the other being a general issue within qualitative/interpretive research. Firstly, adopting ANT as a methodology (see Mitev, 2009 for a discussion on ANT as both theory and methodology), requires a commitment to follow the actors. I take this to mean that any description, discussion, and analysis should be carried out at the point where participants reveal their worlds through the data. If the work of the researcher is to show the network traces, translation efforts and points of passage or present the details of heterogeneous engineering, I feel this is best achieved at the same moment as presenting the data, before they go cold, as it were. Thus, in the findings section I have already commenced the task of presenting analysis and discussion. However, I will present a formal discussion chapter after the findings, which will extend and elaborate on key ideas that emerged throughout the findings.

The second point deals with the nature of qualitative research and the world-making position of the researcher. The rhetoric of positivistic social science sets up a methodological distancing between the objective world of brute data and the analytical work of researchers (Firestone, 1987). However, this division between the object and its representation has been met with criticism from commentators who are more inclined to the position that the world(s) in which we inhabit are a constructed and reflexive accomplishment. This is true, not only to the actors who inhabit that world, but also the researchers who investigate it (Silverman, 2004; Mason, 2002; Woolgar, 1988). Thus, there is no separation between presenting data and deriving understanding from it. All research activity, suggests Woolgar (1888), is an interpretive act. Even when data is presented as stand-alone evidence of objective phenomena in the world, we are taking an interpretive stand that has to consider why particular pieces of interview data is presented and not others, and what kinds of representations are we trying to build by selecting these particular stories.

3.8 Layout of the Findings

The first section of the findings describes the setting of the ICU and the wider hospital. Within this section, I provide a description of the environments, the layout of the ICU and consider some of the technology which nurses use in their nursing care practice. The observations also contain some reflexive features that situated me, as observer, into the world of the ICU. I consider some of the concerns and trials of undertaking an observation study in an environment, which was very alien to me prior to starting out to explore nurses' interaction with technology in the ICU. Along the way, I highlight particular occurrences that depict the everyday activities within the ICU and attempt to throw some conceptual and theoretical light in terms of their network properties. Following the section on the observation of the ICU, I present the findings from the interviews. In doing this, I have decided to divide the findings into three areas of interest. Firstly, I present and discuss those aspects of nursing practice around technology that suggest the dependency of nurses on technology. However, as I carry through the presentation of findings, my aim is to shift the idea of determinacy and dependency and to look upon the particular interactions highlighted as effects of network interaction. Similarly, in the next chapter I start to address nurses' shaping of technology and again work with the data to reveal the network influences that nurses use to re-order the semiotic meanings placed on technology, particularly with regard to their interaction with medical staff. I also explore the relationality of nurses and patient's relatives in the technological milieu surrounding patient death.

In the final section, ideas of technological determinism and essentialism are diminished, as I attempt to develop a fully ANT explanation of the progression of patients as technological bodies, to patients as social beings. The idea of a changing or mutable patient form is derived from nurses' representations, which are in turn mediated by the techno-human network. I finally discuss the idea that two forms of vigil inform the lived-world of ICU nursing: the *care vigil* and the *technological vigil.* I suggest that both of these vigils are once more the result of a host of heterogonous elements operating in the dynamics of network interaction.

4.0 RESEARCH FINDINGS

4.1 The Observation Study on the ICU

In this section on the observation study of the ICU, I have chosen to write in a style that reflects the practice in ethnology work that places the observer-writer within the culture that is being studied (Van Maanen, 2011; Charmaz & Mitchell, 1996). I have taken this approach not simply to convince others of my authorial position- the "I was there, and this is how it was" stance, to garner empirical veracity. I hope there is an element of this in what I write, although the main aim is to take up a more modest approach to storytelling, which recognises the partial nature of the world that comes from one voice. Old standards of ethnographic practice might have been to remove any notion that the writer is involved in constructing the world they are also investigating through conscious obliterating of the 'I'. On this point Crapanzano (1977) notes that, "anthropologists appear particularly disturbed by the presence of the personal pronoun in a "serious work" (p.69). Today, the ethics of observation place the writer in the midst of the

phenomena/culture under investigation. As Charmaz and Mitchell (1996) point out, "we advocate developing an audible writer's voice that reflects our empirical experiences; voices ranges from the evocative to the analytic" (p.285). I attempt in the following section to move into describing the ICU, by retaining an authorial 'I' presence. As I move through the ICU world, I want to relate my observations in ways that move, in turn, from evocative description to analytical insight.

4.2 The Hospital Environment

The intensive therapy unit is situated on C floor of a large East Midlands teaching hospital. Described as one of the largest acute trusts in England and purpose built teaching hospitals in Europe, it provides services for over 2.5 million residents in the East Midlands. The centre holds 87 wards and around 1,700 beds, with 25 surgical theatres. The main hospital was completed in 1978 and presents a somewhat stark and functional exterior to the visitor. The main building is made up of four Blocks: north, south, east and west. All four blocks intersect to create several miles of corridor space. As one enters through the main foyer into the hospital, visitors are met with a busy main concourse that resembles the new approach to designing hospital reception areas. In this first space there is now the ubiquitous array of coffee bars and boutique shops selling gifts, flowers, and in this particular area, leisurewear. The rise of this development in 'front of house' hospital spaces has emerged with the increase in recent UK governments sponsorship of Private Finance Initiative [PFI] (Macnaughton et al., 2009; Gesler et al., 2004). Although the hospital is not a new build, recent refurbishment of the main foyer and reception responds to NHS initiatives to develop hospital environments, not only as places of clinical management, but also as therapeutic spaces. Along with an effort to adapt hospital spaces as environments to promote wellbeing (Kearns & Barnett, 1997), there has also been an effort to link wellbeing and consumerism in hitherto market free areas like clinical environments. Part of the shift within hospital environmental planning has been to instigate the same consumer activities involved with everyday life. As Gesler et al. (2004) state: *"Healthcare providers are responding to these consumerist pressures by introducing to clinics and hospitals consumption spaces similar to those of private, commercial outlets including shops".* (p.118)

In proximity to the cultural symbols associated with health and healing, the consumerist culture creates a buffer whereby consumer identity as sovereign choice-maker is exercised before the perceived loss of autonomy is experienced by patients in the hospital setting (Gilmour, 2006; Taylor, 1979; Goffman, 1970). These through-places in effect act as liminal spaces of transition, where the forces surrounding consumer identity are eased and prepared for transformation into patient identity. The upshot, according to commentators, is that hospital designers have shifted attention onto constructed environments that tap into those symbolic representations, which accrue around shopping activity. As Gesler et al., (2004) state: *"This has meant that the new generation of hospitals seek to reconcile many of the traditional functions of hospitals (i.e. surgery and post-operative care) with a consumer-oriented role as accessible providers of health care, advice and treatment. These shifting goals are, however, being encouraged through a diverse range of design features, encompassing modifications to the social, symbolic and physical spaces of hospitals".* (p.126). However, the use of health environments as areas of consumer culture raises questions regarding the suitability of the contrasting environments and their service to medical practice. For as diverse as individuals can be, the appropriateness of these therapeutic endeavours lies in the eye of the beholder. Thus, the efficacy of consumerist environments in hospitals remains a contested idea (Gesler et al., 2004). Returning to my own apprehension of the hospital reception, one is struck with the scale of human traffic. Of course, this is a busy hospital and one would expect the general through traffic of patients, visitors and hospital staff, but there is surprise at the amount of people participating in consumer activity around the shops and cafes. I arrive for my first fieldwork session at around 10 am and the cafes are bustling with hospital staff and visitors purchasing drinks to sit in or take away. Having all the presence of a town centre shopping mall, the shops and cafes are open fronted, blurring the distinction between being in the shop and standing out in the corridor. The main reception has the look of hotel reception about it, where corporate blazer-wearing staff greet individuals in a manner suggesting 'hospitality is our goal' and 'can-do' efficiency.

I was reminded on this occasion and on others as I passed through the hospital portal; entering the 'hospital mall' of observing the scene as a 19th Fin de siècle *Flaneur:* I observe, taking in the cultural scene, attempting to understand the activity that unfolds before me. I like Mike Featherstone's (1998) description of the flaneur and the activity of flanerie. Taking his cue from Walter Benjamin's (1999) description of the Parisian arcades, Featherstone sees the flaneur as an important documenter of city life. Of course, the hospital is not a city, but neither is the hospital a shopping precinct. There is something strange about apprehending these cultural forms as texts: a coffee shop with open front and near by a patient stands in long bed gown pushing along their portable drip stand. While ambulances arrive or depart with trolleys bearing patients, to whatever destination throughout the hospital or city beyond the entrance, two women are perusing the clothes rails in the open fashion boutique. There is something about the juxtaposed reading of consumerist and patient, and the indeterminacy of context, that un-anchor expectation of the

hospital visiting experience. This arrangement of forms, so appealing to designers striving to create new therapeutic environments, sets up, as Featherstone (1998) comments, "no place spaces" (p.910).

During the period of observations, I have come through the main entrance at different times of the day: morning, afternoon, and evening. After 5pm, when the shopping stops, the usual scene of a few patients and visitors mulling around the foyer, takes over. Everything appears sedate and hushed, compared to the hustle and bustle of the nine-to-five of the hospital-shopping nexus. Much of the efforts to change the design of hospitals, and introduce these oases of consumerism, along with strategic positioning of art objects (Macnaughton, 2007) is geared towards assisting people with wayfinding around large hospitals (Rooke et al., 2009, 2010; Easter, 2007). The hospital is an older building, designed in the early 1970's along functional requirements; it shares none of the ethos of the new movement in hospital architectural design to enable visitors to negotiate their way through the hospital. There is an absence of features such as asymmetric spaces that act as marker points for people to remember and recall as they their negotiate journey. Beyond the main entrance, patients and visitors are met with a series of long corridors, each one non-distinct from the other. Making one's way to the ICU from the main entrance involves a lengthy walk following the signs through corridor spaces. After a number of visits, I learned to discern one corner turn from another as the paintwork shifts from a calming aqua green to a garish salmon pink. I recall that the time between my initial access visits to the ICU and commencing the actual fieldwork, I turned up at the wrong ward. I was quickly put right and sent on my way to find the ICU down another two barren corridors.

4.3 Entering the ICU

The ICU is entered through a series of double doors. The first set of doors takes you from the main hospital corridor into a small space of around three meters square. Facing the doors from the corridor is another set of double doors. On the walls in this space between the ICU unit and the hospital thoroughfare, are information posters giving visiting times and infection control information. Another poster near the doors entering the ICU asks all people entering the unit to clean their hands using the antiseptic gel dispenser fixed the wall. It seems obvious as I observe the small space, that it functions to order the coming and going of human traffic, more specifically, bodies and their harmful microbe detritus. I will say more about how this area operates as a boundary between the ICU and the rest of the hospital later, when I explore way in which technological interaction orders nurses' embodiment. After washing my hands I am then standing at the intercom unit on the wall next to the double doors that leads on to the main unit. I read the instructions 'please press button for attention'. Next to the intercom a further notice says 'do not let others follow you into the unit' – more efforts to control bodies. On pressing the button, I wait for a response and after some time a voice asks if it can help me. On the lengthy walk to the unit, I have rehearsed what I will say: "Hello, yes, this is Brian Crosbie PhD student; I'm starting observations on the unit today". There is a moments silence then the voice says, "Hold on a minute please". There is the sound of the intercom going dead and I wait for some time before the voice says, "Okay come through".

I enter the environment and immediately notice the noise of the unit. There are bleeps and buzzes going off all around. I first approach the reception desk, which sits immediately opposite the main entrance I have just come through. Around the long desk, a few professionals in uniforms and scrubs stand or sit; chatting or silently surveying a computer screen. I move forward to the desk and speak to the receptionist. Again, I introduce myself and ask for the consultant nurse. Unfortunately the consultant nurse is not in the unit today, but if I wait a moment, the receptionist will find the nurse in charge. After some time the nurse in charge approaches, I introduce myself again and tell her that I was commencing my fieldwork observations today. With a friendly nod, she says 'Oh, yes', and walks towards the reception desk, picks up the ward diary and mentions that the consultant nurse had put something in the diary to that effect. I am asked what I need to do. "Well I just want to familiarise myself to the ward. So if it's okay I'll find somewhere to stand, I'll get started". The charge nurse asks if I want to store my coat and bag. I say that that would be handy, and she leads me to along the ward, past bed bays on both sides towards the 'bottom' of the ward. As we walk, she asks me what my study is about. I tell her it is a study about how nurses use technology. I promptly add that it is not an evaluation; I just want to understand how nurses understand the technology they use. We walk on until the open ward ends at the end of the bed bays, and now we are walking along a corridor flanked on either side with what appears to be offices and store rooms. At the end of the corridor, just before a large opaque glass door, I am shown into an office room. The nurse in charge says that it will be safe to leave my belongings here. She then states that I can prepare myself, and when I am ready, I can come on to the ward. As she leaves, my thoughts are racing, foremost in my mind is that I wished she had stayed and accompanied me back into the ward. As it is, I get my notebook and pen together, and then try to gather my nerves. Coming out of the office, my head is rushing, there seems a million and one things going off, 'out there' in the ward environment and 'in here' in my head. At a later point I recalled this anxious moment when I read an article by Crapanzano (1977), in which he states the work of ethnography, "is anxiety-

provoking, ego-dystonic, threatening to the ethnographer's sense of self" (p.69). In this particular moment it seems all too true.

I walk back up the ward, smiling at those nurses who turn to notice my presence. I take in each of the bed bays only fleetingly. The ward, on my return, now appears like a hive of activity. There are now a number of nurses standing by beds; walking purposely around the ward, disappearing into rooms; appearing from rooms. All dressed in blue tunics and trousers, they carry out tasks that are, as yet, alien to me. As all this activity carries on, I am still in the effort of calming my nerves. I do not know these people; I do not know this environment. Moreover, it is now my job to make sense of it all.

I had only briefly taken in the charge nurse's appearance and now when I return to the reception space and look around, she is nowhere to be seen among the dozen or so nurses and medics on the ward. I ask the receptionist if she could point me to the charge nurse, whom I had just met. Another male nurse standing nearby says that he will go and find her- I wait. In a minute, the charge nurse comes up to me again, out of the blue (of the mass of blue tunics). We discuss what I need to do. I state that it would be good to find a vantage point where I can observe the ward for the time being, adding that after a time I would like to walk up and down the ward to have a closer inspection of what is going on. We agree on this, and the fact that I will not be expected to enter any bed area that has the screens pulled round. She then leaves me to get on with her work and I am left standing at the reception. I mention to the receptionist, in order to confirm my every movement that I will stand back against the forms drawer, some ten feet immediately opposite the reception. The receptionist asks if I want a chair. "Yes please, that would be handy". I am given a chair, which I push back against a sizeable set of shallow draws filled with forms. This observation station will become the place I will return to repeatedly to write up notes on my immediate observations and conversations with nurses.

I settle down for this first episode of observations. Initially I will spend four hours on the ward, taking in the sights and sounds like a tourist lost in an unfamiliar quarter of a large city. My notebook is open, and in the first minutes and hours, I jot down everything I witness. It occurs to me that in these first moments of observations my notes are snap shots of events or actions. Everything that is going on cascades on me and then upon the notebook I have just bought for my field notes. After sometime of jottings, I collect my thoughts and ask myself what I am looking at. To centre that proposition I write in my notebook and underline the statement:

"How do nurses interact with health technology?"

When I look up to observe the scene, once more the plethora of activities, machines, sounds, people and objects enter my perception and once again, I am caught in the maelstrom of trying to understand what is going on. It will not be the last time, when I will feel the vertiginous sensation washing over me as another tide of phenomena overwhelms my senses. On this first day, I am introduced to 'John', a nurse of some experience. He say hello, and asks what I am doing. I again rehearse my statement, mindful of my supervisors' advice to keep it simple. He asks if I would like a coffee. Saying yes, we leave the main ward, back through the boundary space that is the main entrance and exit to the ward. We are back in the hospital corridor walking towards an opaque glass door at the end of the corridor. Before the glass door, we enter the staff room. There are nurses sitting eating snacks having idle chat, while a large television fixed to the ceiling blares out some daytime TV chat show. John points to the stack of plastic cups, and shows me where the coffee tin is. I prepare a cup and wait while another nurse fills a cup from a water geyser fixed to the worktop. The food and drink preparation counter takes up one whole wall of this room, which measures around 14ft square; chairs are set round the other three walls.

In the middle of the space, a low coffee table is strewn with out of date magazines, of the fashion/ home-improvement kind. In amongst the reading material are some 'in-house' publications, including one on a local critical-care consortium. As we sit and chat, a few nurses finish their drinks and leave; returning to the ward and their duties. I notice along one wall a notice board with various ICU related documents, along with a poster for a night out, and an advert for a car being sold by a member of staff. On the opposite side of the room to the notice board are the windows, which run the whole length of the room. They look out upon a large quadrant surrounded with similar hospital spaces within. The view is stark, as four storeys of similar brick and window space look in upon itself. As I look out of the window, the low winter sun struggles to illuminate the lower floors.

John and I sit and chat drinking our coffee. I ask him questions about the unit and he answers with considerable patience. I am using his answers and knowledge to orientate myself to the environment; I glean straightforward 'facts' about shift patterns; how many nurse are on in a given shift (usually a ratio of one nurse to one patient) and how many male nurses work on the unit. John also informs me of break times, when staff arrive on shift and how the unit is run in terms of changeover meetings and staff teams. John's knowledge, as an initial informant is valuable information, if only for me to get a handle on the unit. As we finish our coffee, I ask if he would agree to being interviewed for the study. He agrees without hesitation. Pleased to have made in-roads in introducing myself to one member of the team, I accompany him back on the ward through the 'boundary'. He punches the hand cleanser

and I copy him likewise, then he swipes his card from the lanyard hanging around his neck and we enter back into the unit. In the ICU, I take up my observation post, open my field notebook and observe. As expected, on this first observation session, I am immediately taken by professionals on the unit as a 'body out of place': why is there a strange man sitting at reception writing in a book? People are bound to ask questions as to why I am there and what I am doing with my paper and pen. As a requirement of ethics, I had given the nurse consultant, an electronic copy of my information sheet for observations. She had emailed this to all staff (as well as placing them in nurses' pigeonholes). However, on this first occasion and on many subsequent occasions, I found myself explaining my presence on the unit. The staff were obviously curious as to the notes I was making in my field book. After explaining for the umpteenth time, one nurse says, "That's okay- before the Chinese whispers start".

I have since reflected on nurses' initial suspicion over my activities, considering how this might have impacted on any subsequent observations and interviews. I believe that on detecting some initial unease from staff over my presence in their work environment, I made as much effort as possible not to appear detached from the social activity of the ward. Although my role was as a non-participant observer I strived to connect with nursing staff by 'shooting the breeze' whenever the opportunity arose; joining them during their breaks in the staff canteen and by sharing informally some of the observations I had made.

Looking back, those first few observation sessions held moments of acute anxiety regarding how I might approach people to introduce myself. I was caught between not wanting to disturb nurses as they went about their tasks, and feeling myself rather rude about coming into others' environment without introducing myself. On that first observation episode, some people did approach me and ask out of curiosity. I was grateful for this as it then gave me a later opportunity to approach them as they went about their work. In that first fieldwork session, I devised an observation strategy that I mainly continued with throughout the 40 hours of observations on the ward. During all the sessions, I used the observation hub next to the reception to write up notes of immediate interaction with staff. I also used this observation point to gather information about the general coming and goings of the ward routine: a macro-view of the environment. When I wished to observe at close quarters nursing activity or to talk to a nurse, I would rise from my seat and approach them. As a matter of courtesy, I would always ask the nurse if it was convenient. On occasion, nurse expressed that they were too busy to be observed, or enter into a conversation. This, of course, was respected in the knowledge that at other times the same nurse would be happy to allow me close observations of their task, as well as enter into conversation about their interaction with technology.

4.4 The ICU environment

The following describes the physical environment of the ICU (Figure 1). I will map out the main features of the unit as to give a detailed picture of the main sites of nurse, patient and technology interaction.

Figure 1: Plan of the ICU

To begin with, the main open space of the unit; it is a large rectangular area, it measures around 11 metres wide by 23 metres in length. When one enters through the main doors, the ward reception faces you across the main ward concourse. The reception comprises a 4-metre length of desk space; on top of the reception desk sits the usual office paraphernalia: a computer with unit; telephones, filing shelf and paper binders. To the left of the desk is situated a printer. Behind the desk space there are a number of cabinets, and fixed shelves; a clock sits high on the wall. Behind the reception, a door to the left takes you in to a storeroom. It is here that gases such as oxygen are stored. I was also informed that this area also contain a locked store for class A medication. Directly opposite the reception, is situated

the main double door entrance- previously described. Situated to the right of the entrance doors is another store, which houses medical supplies. Between the reception/store room and the entrance/store room area the open space of the ward narrows to around 4 metres. In effect, this narrowing divides the open ward space into two areas.

Standing at reception and looking down the ward long-ways, one takes in one of the main bed areas [bed area 1]. With the main concourse down the middle, there are four bed-bays to the left, up against the windows that stretch the full length of the open ward, and four bed bays to the right, against the opposite wall ward. Turning around 180 degrees, there is the same layout, with four beds against the wall and four up against the window space [bed area 2]. In detail, the environment resembles the classic Nightingale ward, with bays on each side, albeit with distinctly fewer beds. At each end of the two bed areas, one and two, the ward narrows to corridor space. Taking in bed area 1 the corridor leads off into an office and storerooms. Immediately on the corridor is situated the ward's isolation room. One wall of this room faces onto bed area 1 at the window side of the ward. The wall has a large window space through which the activities going on within the room can be observed from bed area 1. Carrying on down the corridor leading from the central concourse of bed area 1, on the left beyond the isolation room, are situated two offices. These are general administration offices, though one acts as a nursing administration office and the other, at the end of the corridor, is for general ICU administration. These two offices would later be used for many of the interviews with nursing staff. At the end of this corridor is a large sliding door of opaque glass. The door is large enough to allow the exit and entry of ICU beds. The area beyond the glass door has a reception space and a lift, which brings patients up to the ICU from other areas of the hospital, mainly surgery and emergency admissions. This area can be described as a further boundary space, as it is clearly marked for hospital staff only. A button near the sliding door allows staff to exit. Entering the ward from this area requires staff to swipe their identity card. Although this entrance is the entry point for bedded patients coming onto the unit, the access also allows staff quick passage to the main hospital entrance and the shopping/café area described earlier.

Returning from this boundary space back onto the corridor leading to bed area 1, there are four more rooms on the left. These comprise of a small room designated as the nurse consultant's office. The next room is a further storeroom housing medical supplies such as medical kits. The room also accommodates one of the two blood-gas machines on the unit. Historically, this room is described by staff with long service on the unit, as the dressing room, where patients in previous times would have their surgical dressings changed. The last two rooms before entering bed area 1 are used for patient washing preparation and waste disposal. Beyond bed area 1 and the reception and main public entrance, lies bed area 2.

Further on up, the ward again narrows to a corridor with rooms similar in layout. Facing the corridor, on the left is the medical equipment storeroom, which also houses the second blood-gas machine. In this room all the medical equipment and technology used on the ward is kept on shelves and along the floor space. On one counter built against the wall there are a number of pieces of portable equipment. Next to this equipment, battery chargers blink green lights showing their status. On other shelves in this room further medical technologies are prepared for use. Among the larger equipment are the filtration/dialysis machines. Recently new filtration machines have been introduced to the ward. They are not stored here, but in the seminar room across the corridor.

Entering the seminar room, there are chairs laid out in orderly fashion around three walls. A stack of chairs is propped up in the corner. The room also contains some audio-visual equipment and a desktop computer. As the name suggests, this area is used for staff training, and on the poster boards on one wall there is a training schedule, along with newsletters and other training opportunities. There are folders containing equipment and policy manuals placed on shelves on the walls. A flip chart and stand is poised towards one end of the room. There are also the new filtration machines, one still half wrapped. At the time of observing the room, staff were involved in a schedule of training and demonstration of the new machine. The seminar room also hosts the nursing staff hand-overs. All staff coming on duty meet here to hear a report of the previous shift from the nurse in charge. After the main handover, nursing staff break into smaller meeting groups that are assigned to groups of patients on the unit. Following the team report, each nurse coming on shift receives an in-depth hand-over for his or her specific patient from the nurse finishing duty. One other room in the corridor off bed area 2 is designated as the staff changing room. The room can be accessed from the main hospital corridor. As expected, the room is full of tall lockers for staff to place their belongings before coming onto the main ward. The above section has described the physical environment of the unit. It is appropriate now to focus in on the patient bed bay. As a site of central importance in nurses' care practice, a detailed description of the features of this space will indicate the importance of this space with regard to nurses' interaction with technology. I will highlight typical 'fix' devices that make up the ICU bed and its surroundings.

4.5 Technologies on the ICU

I have thus far described the ICU environment, but as it stands these spaces are empty and require populating with objects, artefacts, and human agents. I want to go on to describe firstly the standard forms of health technology that are likely to occupy the unit space. I will discuss ICU beds, ventilation machines and other sundry equipment used in nursing intensive care patients. I will pay particular ethnographic attention to two devices: the blood filtration machine and the blood-gas machine as exemplar technologies. Through ethnographic exploration of my fieldwork observations and theoretical insights from society and technology studies (STS), I will illustrate the nuanced nature of nurses' interaction with medical devices. Recent advances on ethnographic methods have explored the central place of technology in social interaction. As Hess (2001) has indicated, much of what counts as classic ethnography of science and technology has hitherto ignored, or at least paid scant interest in, technology as a player in the materiality of social action. Taking their cue from earlier ethnographies from Actor-network theory(Latour, 1987, 1988; Callon, 1986a; Latour & Woolgar, 1986), studies such as Prout's (1996) investigation of the metered dose inhaler, and Singleton and Michael's (1993) exploration of General Practitioners and cervical screening , examine the contested nature of technology use in clinical practice and have developed approaches to studying technology in ethnographic detail. At the core of this programme has been an effort to bring parity of agency between humans and technology, by engaging with what ANT writers call the 'material relationality' (Law, 2009). Accordingly, what might be described as human and non-human action is an outcome of a contextualised relational performance.

4.6 The Intensive Care Bed

The ICU main ward area has 16 beds (there is one in the isolation room). In each case, an intensive care bed represents a sophisticated technological apparatus. The bed, as one would expect, contains a high degree of articulation across its frame; enabling nurses to position the bed mattress through a push button interface built into the side barrier of the bed. Small pictorial signs reference each button, acting as a guide for nurses when manipulating the positioning of the bed frame and mattress appropriate to the patient's condition; not least to prevent pressure sores in the patient (Clochesy, 1996).

Figure 2: Typical ICU bed with monitor and driver on stand

The intensive care bed is itself a focus of technology. Aside from the rudimentary bed frame, which boasts multiple articulations, automated through motors and pumps, the mattresses also offer a high level of technological sophistication, as one of the nurses interviewed defines it*: Mn01, male nurse: "Well the bed is a piece of technology itself. It goes up and down and side to side. We've got more complex beds we'll use with sicker patients, which can vibrate to help their chest."* Above, a gantry runs along all the bed areas. At each bay, the gantry delivers fixed electrical sockets. These are used to power any devices being used for specific patient care. From the gantry is also suspended the monitor, one for each bed. The monitors are a vital source of information on the patients' physiological status: offering traces on heart rate; blood oxygen levels, blood pressure and respiratory rates. On every hour, it is the duties of the nurse assigned to each patient to record and chart these vital signs. Surrounding the head end of the bed there is a portable trolley, which holds objects of various nursing paraphernalia; used by staff to carry out routine tasks directed at patients' personal hygiene.

Each ICU bed is the site of sophisticated technological apparatus. Depending on the patient's illness, the nurse, whose responsibility it is to manage this space will be expected to ensure the functioning of an array of medical technology. In order to have an overview of the technological network, which is interfaced with the patient, the ICU nurse's observation position is taken up at the base of the bed. There, sat at a high desk, which is on wheels, nurses have an encompassing view of both the patient and technology that surrounds them. On the desk, which has a slanted surface, is the large observation sheet, made up of separate charts for each physiological observation- heart rate, blood pressure, ventilation etc. Of course, there is order and purpose as to the position of the nurse in relation to the patient and monitoring devices. I record in my field notes that: *I'm observing the nurses attending to patients on the left side of the ward. Three of them are sitting at their respective desks. One nurse is busy recording her observations. She looks up from the observation sheet towards the monitor and then records the figures. Again, the nurse gazes at the monitoring device, and then returns her attention to the observation sheet. It seems to me that the position of the observation desk seems apt for both patient and technological scrutiny.*

Later that same shift I speak to one of the nurses about the position of the desk in relation to the patient. *Mn17, Male nurse: "Well you can see everything…I look at the monitors before I look at the patient. We've got a few things to record, so here you can get it all down at the same time."*I notice after regular observation that most of nurses' time, when they are not working around the patient, is taken up with sitting at their desk. From here, they might chat to other nurses also sitting at their desk, or indeed visit other nurses' desk to chat. It is in effect the nurses' area of domain. From this station, nurses operate the panopticon of the nursing gaze. Every item of technology - monitors, syringe drivers, ventilation machines, is ordered and positioned to serve the observational requirement of ICU nursing. Furthermore, the patient is revealed and ordered in the medical gaze through the myriad of technology that discloses knowledge of the inner illness. Noted by Henderson (1994), using a Foucauldian perspective, the panopticon of the medical gaze in ICU demands the subjection of the body to technological scrutiny for the production of knowledge. However, like all panopticon, the scrutinising gaze is reflected back upon the observer, in this case, the nurse. In the network of patient technology, the nurse is also ordered through the regular requirement of routine observation (Epling, 2003). The observation sheets, and other similar nurse recordings, becomes objects through which nurses are scrutinised (Timmons, 2003). This panopticon, reflected back on nurses, was made clear to me when I asked what was done with the observation sheets besides recording the ongoing physiological status of the patient. I was informed by a number of nurses, that completed sheets were regularly taken away and checked for auditing purposes. As one nurse put it:*FN 14, Female nurse: "So they can see if we're completing them properly. And if anything is disputed about the care people have received here."*

4.7 The Ventilation Machine

Under direction from medical staff, nurses operate a plethora of medical technology; these may be deployed at the bedside of patient in accordance with the condition and the life-support needs of the patient. Among the technology most cited by nurses in interview is the ventilation machine (see figure 3). The devices are of course stand-alone portable devices, used to support the respiratory function when the patient, due to their medical condition, is unable to breathe on their own. The control of ventilation is managed through an interface screen, which displays particular features of the patient's respiratory rates. With particular therapeutic interventions required in accordance with the patient's condition, the nurse is able to take 'readings' from the computer screen and make adjustments in line with the consultant's prescribed therapeutic regime.

Figure 3: Ventilation machine

4.8 The Blood Filtration Machine

Continuing with the potential catalogue of bedside technology, nurses may be called upon to set up the Aquarius filtration machine (Figure 4). Of all the technology described by nurses, according to interview testimony, this is the most sophisticated device they have to work with, and the one that requires a great deal of attention to ensure it is functioning correctly and efficiently. Similar to other devices the machine is portable and stand-alone and is brought to the bedside when required. The machine stands on a metal frame, and the main section of the filtration machine - trade name Aquarius - presents a configuration of cam pumps, which push the patients' blood through the filter. In setting up the various tubing and conduit lines, the user is assisted by coloured lines reflecting the correct pathways for the tubes (Figure 5). Marked onto the front of the machine, these distinctive coloured lines of blood direction have topographical representations that bear resemblance to Beck's famous London Underground map (figure 6).

Figure 4: Aquarius ventilation machine

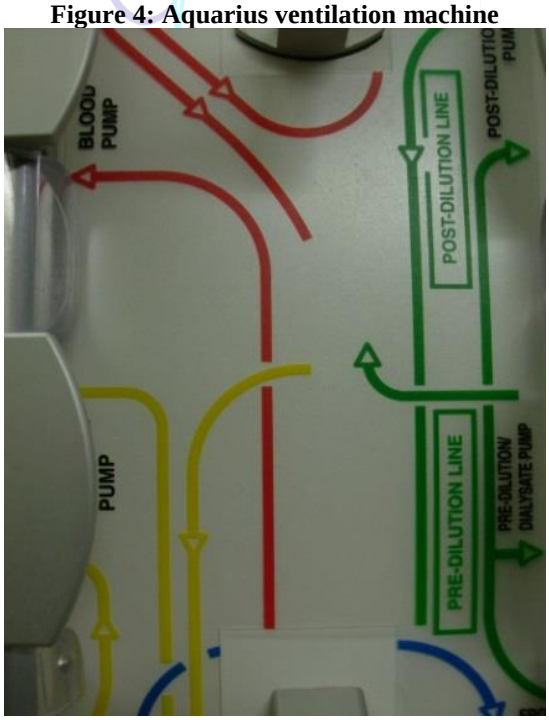

Figure 5: Close up, filtration tube pathway

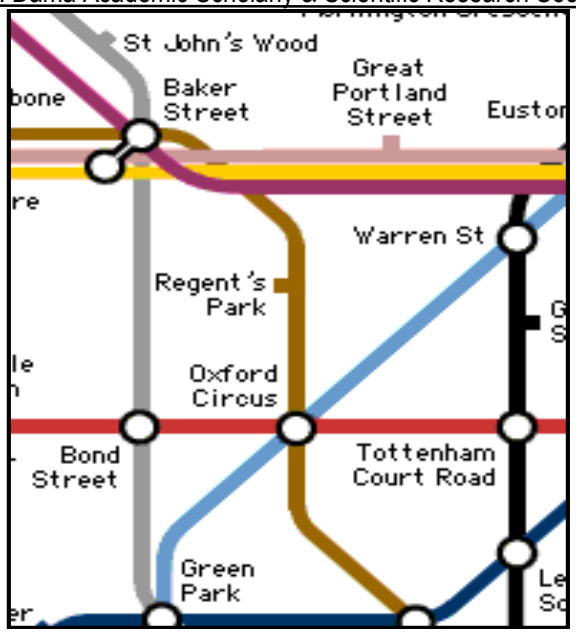

Figure 6: London Underground map, Harry Beck 1931[1]

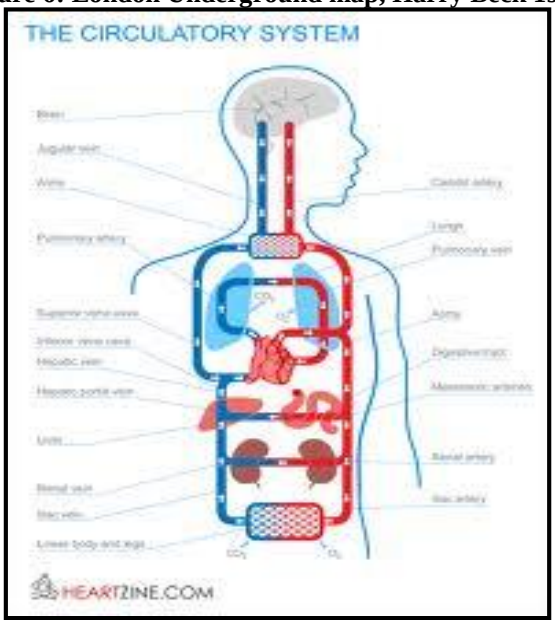

Figure 7: Diagram of circulatory system

Although no direct mapping of the Aquarius machine's filtration pathways can be directly construed from the figurative diagrams in figures 6 and 7, the similarity of 'text' and the mode of representation i.e. uncluttered symmetry, reduction to salient features of the system, is one we are all familiar with today in modern design vocabulary. In particular, nursing and medical students, through their training in physiology, would be familiar with the diagram of the blood circulation system represented in figure 7. It is the designer's use of a particular and recognisable representational form, which ensures the correct placement of the conduit tubes on the Aquarius filtration machine. Technological configuration in design co-opts those using the device. It is an indicative example of what ANT theorists consider a translation of users into the network of the filtration machine. This is to say that the design's resemblance to similar features of other technologies taps into recognisable forms- be they transport maps or physiological texts books - which ensures the opting in of nurses as users of the filtration machine. The key point

[1] Permission to use the London Underground map was granted by Pulse Creatives.

here to note is that all those who are recruited into the network, which by definition contains multiple interested members including technology designers, health policymakers, filtration machines as well as nurses who use the machines, all work as heterogeneous engineers (Law, 1999). The following quote from Law (1999) sums up the ANT approach to social and technological relationality: *"Actor-network theory is a disparate family of material-semiotic tools, sensibilities and methods of analysis that treat everything in the social and natural worlds as a continuously generated effect of the webs of relations within which they are located. It assumes that nothing has reality or form outside the enactment of those relations. Its studies explore and characterise the webs and the practices that carry them. Like other material-semiotic approaches, the actor-network approach thus describes the enactment of materially and discursively heterogeneous relations that produce and reshuffle all kinds of actors including objects, subjects, human beings, machines, animals, 'nature', ideas, organisations, inequalities, scale and sizes, and geographical arrangements."* (p.2)

In any given context of relationality between these actants, in this instance, nurses and filtration machines, actor network theory insists that the heterogeneous engineering is as much an achievement of the technology as the nurse. It is the design of the technology, as one component of the network, as material-semiotics (Law, 1992) that is to be 'read' and thus more or less understood by the nurse using it, that enables a point of heterogeneous engineering of the nurse into the network of blood filtration. Of course, this is not to ignore the other members of the network who can be traced back from this moment of technological use by nurses. However, this moment of technological adoption suggests a 'natural history' of both the technology and the nurse as members of the blood filtration network. Much of what I write about with regard to nurses' use of technology contains this element of network recruitment, which helps to stabilise the network and ensures the continued use of the technology. However, I will add a note of caution: the semiotic nature of technological use affords a dynamic reading of the technology, in that not all understanding and use of the technology might be in line with the technological affordances insisted upon by the technical network. In some circumstances, nurses' 'reading' of the technology opens up alternative uses of the technology that address social affordances beyond the stable network of blood filtration (Hutchby, 2001). There is more to be discussed on nurses' work with filtration machines. I will leave this for a later chapter where I present the findings from interview data. At that point, I will further elaborate on ANT in relation to the analysis of nurses' accounts about the different technology they use.

4.9 Prismaflex- the new state of filtration technology

At the point when observations commenced, the ICU was in the process of moving over to new filtration machines. The technological innovations of the new filtration machines included a computer interface that takes the nurse through the various steps, ensuring each step is completed in accordance with the requested filtration procedure. The new filtration machines - trade name 'Prismaflex'- like the older Aquarius machine has a built in computer interface. Comparing both interfaces, the Aquarius screen presents the user with options as to the particular filtration prescribed. This presentation is similar to the Prismaflex, as each option button on the touch sensitive screen takes the user further into the set up. While in operation, both machines give a constant report on the status of the filtration cycle, alerting the nurse to particular calibration requirements that have to be carried out to ensure the correct function of the machine. Throughout the filtration procedure, which might take up to three hours or more, a sizeable part of the nurse's time is taken up with maintaining the technology to ensure correct filtration.

In what was described as a step forward, the new Prismaflex differs from the old technology in its ease of setup and operation. The interface platform is made more user-friendly with the step-by-step screen pages resembling the familiar pages of a Microsoft windows programme, with touch screen radio buttons assisting the nurse through the various filtration options in the set up. The Prismaflex boasts the ability to change between different filtration therapies without reconfiguring the filter. The new Prismaflex offers greater safety features that ensure correct use in terms of fluid outputs and inputs to patients. As expected, the literature accompanying the device, lists developments in the technical features of the new filtration from previous filtration devices, with emphasis placed on the science of filtration. Adhering to the discourse of science to sell the appliance is an important strategy in building support among professionals who will use it. Whether those professionals, who will eventually apply the technology to patients, are fully knowledgeable as to the intricacies of science, technology or electronics behind the practical use of the machine is perhaps secondary to their acceptance of 'science' qua science, as a powerful mediator in technological adoption. The use of science 'talk' is a powerful discourse that, "in the first place is the conflation of knowledge and truth" (Aronowitz, 1988, p.vii), which through its realist methodological insistence of direct knowledge of the world of 'truth' and 'reality' demands acquiescence from society. Certainly particular members of the nursing and medical staff responsible for its use will rely on science talk as an acceptable guarantee of the machines effectiveness; again, semiotic-materiality is at work in providing a reading of the technology that ensures the recruitment and translation

of actors into the network of filtration. The following text (Figure 8), taken from literature on the Prismaflex, highlights the machine's effectiveness couched in the language of science of renal physiology:

- **The Prismaflex system** offers three types of membrane for CRRT (AN 69, AN 69 ST and PAES) with three different surface areas for each membrane.

- **Therapeutic plasma exchange and hemoperfusion*** The Prismaflex system can fulfil the needs of both adults and children for therapeutic plasma exchange and hemoperfusion, since it is compatible with two different sizes of membrane surface area and cartridge.

- **Innovative membranes for new possibilities in blood purification*** OXiris- a Prismaflex set with unique membrane ability to adsorb and remove endotoxins
- SepteX- a Prismaflex set featuring a proprietary Gambro high cut-off membrane technology, able to remove and reduce plasma levels of high molecular weight toxins (e.g. cytokines)

- **Optimized combination with the MARS liver support system** The Prismaflex exceed II system provides a unique compatibility between Prismaflex and MARS systems by means of a dedicated user interface and a specific-MARS kit to simplify the treatment of patients suffering from liver failure. (Published by Gambro Lundia AB, retrieved from www.gambro.com June 2011)

As Pinch and Bijker (1984) suggest, the successful adoption of new technologies requires the investment of a relevant social group that coalesces around the artefact giving it meaning and function relative to the needs of the specific group. Nevertheless, calling up science as a discursive strategy to insinuate the effectiveness of the filtration machine is only half the story. Not all users and members of the relevant social group will be in possession of science knowledge. There is therefore the need to frame the effectiveness of the device in language appropriate to the requirements of other group members. The requirements of the technology may be other than scientific, they may require an appeal to discursive constructs surrounding societal notions of expressive care and concern for human life, or the effectiveness of the technology to provide more time caring directly with the patient. From the same document, the following excerpt (Figure 9) can be said to appeal to these very aspects of nursing practice as a form of expressive care and human endeavour: *Hundreds of thousands of men, women and children around the world… rely on our products and your care to survive kidney or liver conditions and enjoy a better life. Every step we take together, every improvement in care we make, touches lives and provides new hope ... Gambro—the pioneer and leading innovator in dialysis therapy passionately committed to promoting life by advancing products, services and customer partnership within renal and hepatic care…*

Quick and easy to use: *The Prismaflex system incorporates a 12-inch color touch screen with an intuitive user interface. This provides constant monitoring of prescription delivery thanks to the clear display of all necessary parameters on the status screen. Step-by-step instructions on screen make set-up easy. Each step is accompanied by an illustration with color codes matching the color-coded hemofilter sets. Any prescription change can easily be made with clear accessible softkeys.* (Published by Gambro Lundia AB, retrieved from www.gambro.com June 2011)

Figure 8: Prismaflex- highlighting the technology in nursing care

The brochure goes on to state that with ease of use the Prismaflex® gives more time to be with the patient as well as reducing workload and stress. With the example of the *Prismaflex* filtration machine (Figure 10), I want to suggest that there is a double epistemology between the scientific and the social, which strives for a symmetry of technology, similar to Bloor's studies in the Strong Programme of scientific knowledge (Bloor, 1991; Pinch & Bijker, 1984). That is to say, technology, in order to be successful, has to 'work' in the realms of the science-world and in the social-world. In this way, designers and manufacturers as heterogeneous engineers in the filtration network have to appeal to the social component to ensure that the machine is adopted by all the relevant social groups likely to enter the filtration network orbit. To this end, the device may succeed as a black-box 'technology' in that the electronic and computational infrastructure 'work', and ensure the machine functions according to its technological affordances. However, as a social object it may never be taken up.

Figure 9: Prismaflex dialysis machine

Figure 10: close up of filtration apron

While the transition from the older Aquarius machine to the Prismaflex was taking place, there were a number of demonstration workshops offered to nursing staff to familiarise themselves with the technology before they were expected to use it on patients. I was able to observe two of these workshops, conducted in the seminar room, which were run by a sales representative from the company selling the machine. The demonstrations lasted forty-five minutes. Within that period, I observed the sales 'rep' appealing to both epistemologies - the scientific and social in equal measure. The demonstration highlighted the functionality of the Prismaflex in terms of the renal therapy regimes that nurses and medical staff would most likely use, and illustrated the effectiveness of the machine to manage the patients' therapeutic requirements. At other times, the demonstration would concentrate on the practicalities of handling the machine, including the positioning of fluid bags at a level that lessened the physical effort nurses were required to undertake when disposing and replacing bags.

Similarly, much attention was placed on setting up the machine and the ease of situating the integrated filtration kit by means of colour-coded tubes and corresponding insertion points. The sales 'rep' focussed on the ease with which the device could be set up, to enable the nurse to spend more direct care time with the patient, whilst the device worked discreetly in the background. In this respect, the demonstrator attempted to contrive a narrative that places the technology as affording greater social interaction through discursively positioning the patient nurse relation at the centre of care. I noted in my field book at the time:

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The device trainer attempts to relate his understanding of the needs of the nurses to have useable technology free from complexity and complications. The nurses are talking about the problem of picking up on the new machine when they have got used to the old one- with all its foibles. The demonstrator then manages this situation. He expresses his understanding that change requires new skills, but while necessarily distancing the new technology from the old, to ensure that nurses are to some degree comfortable with the new device, he has to sustain the idea that practical knowledge of the old device will help the nurses understand and manage the new machine. The conversation now surrounds the trainer/demonstrator negotiating the nursing and technology communities. His job is to introduce the technology by making it meaningful to their practice. As the trainer goes through the set up on the screen, I notice that nurses start to voice unease at the apparent complexity of going through the different platforms and menus on screen. One nurse mentions, to no-one in particular, that "you've lost me." In his response to this- and other comments of evident strain and confusion- the trainer mentions the words "not to fear" in relation to the use of new technology. The trainer promises to reduce this apprehension by offering a continued period of support: "I want to be around to help set it up with patients"… "I'm a phone call away if you have any questions"…He also mentions that for a period of time he will be on hand to assist with the setup while the AICU is getting used to using the new machines. The trainer/rep mentions to the group that he worked as an ICU nurse. He is managing this performance by engaging nurses with the technology by using his own experiences to highlight that he understands what ICU nurses need. So, he relates stories of nursing with technology that was useless in delivering safe patient care.

I recorded at the time of attending the demonstrations of the Prismaflex filtration machine, that the trainer/rep performance was exemplary in its effort to engage the nurses and helping them opt into using the new device. He used a number of strategies that 'spoke' to the concerns of nurses. Foremost among these strategies was revealing his nursing credentials. As an ICU trained nurse, he was able to empathise with nurses through sharing in stories around nursing technology. I want at this point to pick up on what is happening here with regard to this intersection of the Prismaflex filtration, the sales representative and the nurses who will go on to use the technology. I would argue that the sales-rep is operating, in ANT terms, as an actant boundary object, bringing together the worlds of design and manufacture on one side and the network of technology and nursing in the ICU. Usually there is no limit as to what can be counted as a boundary object. Studies that have used the concept of a boundary object have presented divergent phenomena as the focus of investigation. For example, Fox (2011) and aseptic technique in surgery; Eden (2011) and food labelling; Harvey and Chrisman (1998) use geographic information systems as boundary objects to inform the transference of information between GIS technology and social groups. As Star and Griesemer (1989) point out, what is important to the function of boundary objects is that they offer a common representation across divergent fields of knowledge. Although Fox informs the debate by suggesting that boundary objects might reverse and indeed cause the discontinuation of interactions across discipline boundaries (Fox, 2011).

Although it appears that boundary objects take the form of hard material artefacts, or conceptual ideas, in this instance, I am suggesting that the sales rep (as actant) acts as the boundary object. The rep, although working in the technology industry, is a registered nurse. In the interaction with nurses, the rep was able to demonstrate his practical knowledge of nursing to translate the contents of the technology (which encapsulates the knowledge of the medical innovations industry) into the practical concerns of nurses. As such, he is able to intersect the two worlds of technology design and the ICU nursing. This knowledge claim: "I am a nurse," operates the easy transition of the new filtration machine across network limits, (speculatively, it could be inferred that the industry employs qualified nurses for this very reason) resolving resistance and incoherence's between the knowledge community of design and manufacture, and the practical knowledge of the ICU nursing world. To do this, as the notes from the Prismaflex training suggest, the rep works to relate the view features of the devices with the existing practical knowledge that already circulates in the ICU network. It might be argued that the new filtration device is the boundary object. However, as I analyse the interaction, it is the rep who is working to inscribe the functionality of the machine into the nurses' normal interaction with filtration technology.

I now wish to describe one further scenario of nurse- technology interaction. In the following example, I will seek to analyse the way that technology orders the activity of nurses. This case looks at the boundary space at the

ward's entrance, where mundane technology (Latour, 1992) - chemical hand gel - informs the nurses' performative actions around the science of infection control.

4.10 The ICU main entrance: negotiating a hygiene boundary

The visitor enters the ICU ward through two sets of double doors. After the first set of doors, one enters a box-like anteroom approximately 2 metres by 3 metres. The doors entering the ward area immediately face you as you come through the first set. The double doors act as an 'air lock' that separates visitors from the main hospital corridor. In this area, there is a certain feeling that one has come into a space of transition, from the hospital thoroughfare with its potential to deliver pathogen contaminates to another space where 'dirt' is left behind. This area works as a transition space both symbolically and physically, a constructed watershed separating an *out-there-ness* of potential contamination, and the *in-here-ness* of cleanliness. These boundaries act on, and are performed through, the symbolic ordering and separation of the ICU environment, from the world outside. By the very nature of the representation in this closed space between out and in, cultural notions of 'dirt' and its impurity are brought to the fore. There are posters on the wall alerting visitors to infection control. Standing against the wall is a full size figure of a female nurse with her hands displayed open. The openness of hands, as well as evidencing cleanliness, works on the individual as a signifier of honesty. To harbour infectious pathogens, and to 'secret' and 'secrete' them in to the ICU is to be dishonest and under-handed. Moreover, this signifier charged area, creates a further symbolic ordering, this time between the scientific war against disease and dirt, and the everyday secular activities, which accrue dirt. The science and the technology used in this boundary space which enforces the practices of purity and hygiene, relies on the cultural significance of 'dirt'. These matters cannot be written about without recourse to Mary Douglas, and the cultural anthropological significance of dirt being 'matter out of place' (Douglas, 1966, p. 35). The following quote from Douglas (1966), addresses neatly the material ordering that occurs when entering the ICU: *"Where there is dirt there is a system. Dirt is the by-product of a systematic ordering and classification of matter, in so far as ordering involves rejecting inappropriate elements."* (p.35) The importance of symbolic ordering of out-there-ness as 'dirty' and in-here-ness as managed and ordered purity, compels visitors and staff to use the disinfectant gel, which is dispensed from the hand machine fixed to the wall. In addition, this space between the corridor and the ward displays posters requiring visitors, both relatives and professionals, to be aware of infection control. There is, of course, a materiality to this liminal space between the scientific and technological controlled purity of ward-world, and the pollutants of the 'social' world. Of course, both spaces are social, but the symbolic ordering constructs the significance of an 'other-world' of the intensive care. The materiality lies in the compelled enactment of cleansing practices: reading the information posters; taking a squirt of hand cleanser. All who visit the ICU must engage with this enactment of purification. If indeed, dirt is matter out of place, the harbinger of this pollution is people. More particularly, the volume of traffic made up of nurses going to-and-fro from the unit.

Much of what is going on in this area is directed at controlling bodies. This is to say, what kind of bodies should be entering the ICU and how other bodies are controlled is an important function of this ordering. Along with the infection control posters, there is the visiting times schedule, laying out the hours when people can visit, and what is expected of visitors' conduct while on the unit. All of these matters are materially important with regard to the clinical management of infection on the unit. However, control of infection as 'dirt' can at times be a two-way-street. During the phase of my fieldwork, a new sign went up. It warned pregnant women that there was suspected swine flu in the ICU. In this instance, there is a reversal of the symbolic order - the 'dirt' is now within the unit. This management of human traffic is underscored by a set of values that are informed by the actor-network of microbiology (Rawlings, 1989). In turn, the theory of microbiology and infection are transmuted through the network made up of laboratory work, policy-maker, protocols, chemical manufacture, and nurses and so on. All these heterogeneous actants are enrolled into a network of hygiene practices, ensuring the people, objects and environment involved with intensive care practice are kept as sterile and hygienic as possible. Thus, a set of practical rules, informed by microbiology, *to some extent*, ensures the hygiene conduct of all within the ICU space. However, as Rawlings (1989) indicates, rules of hygiene compliance are in a sense only symbolic representations of the underlying complexity of microbiology, and as such, socially situated performative hygiene practices- *to some extent*- cannot fully cover all of the underlying materiality of microbe theory. Rawlings (1989) writes: *"Because of this symbolic rather than direct relationship, members of the organisations involved in producing and maintaining sterility treat the rules as practical features of the setting, to be invoked, suspended or followed with reference to other contextual features, such as who is involved…"* (p.281). As a 'novice', naïve to the symbolic performance of hand cleansing, as I enter the main environment of the ICU, I carry out all demands of infection control to the letter. Oozing out a sizeable gob of liquid, I rubbed my hands together for some 20 to 30 seconds until the solution had evaporated. For me, as the new actor on the scene, this space between worlds seems focused on infection control, and I comply with the demands asked of me. I am thinking that all visitors must go through the same action that marks our embodied presence as suffuse with

contaminant risk. We are polluted in dirt and we must pass through the purifying boundary space. As I enact this hygiene rule, I question myself about how much is enough hand cleanser. Do professionals entering the unit do it properly? Surely, their practice is more in line with infection control and microbe theory. As part of my observations, I spent some time focusing on this boundary space and nurses' performative action around this particular site of infection control practice. The following extracts are from my field notes: *A nurse arrives at the double door; she quickly knocks the inverted pump dispenser, rubs her hands together, then reaches for her swipe card to open the door… The nurses is carrying some portable equipment, they prop it on the ledge whilst they pump the dispenser rapidly. They wipe one hand over the other reaching above the wrist, take hold of the equipment again, and enter the unit. I'm at the doors outside the unit, about to buzz for entry. A nurse joins me in the space between the two sets of double doors. She pushes the pump once and the wrings her hands together in a quick and inattentive manner before opening the door and letting me enter first.*

There were numerous times when I observed this action, and on each occasion, it seemed that individuals had established their own response to the demands for infection control. I will come to notice nurses, medical staff, and ancillary staff, paying only cursory attention to the use of the hand dispenser: a symbolic squeeze of the pump followed by a quick wringing of hands will suffice, before swiping their card and dashing through the door. Finishing the above quote from Rawlings (1989), this description of nurses' actions as they negotiate this boundary between out-there-ness (socio-pollutant) environment and the in-here-ness of the ICU (techno-science hygiene), perhaps testifies to the exigencies of 'real' world intensive care practice: *"This is not to make the practical accusation that rules are deliberately flaunted, but to note that the meaning of a rule is a matter for the situated practical judgements of the people concerned."* (p.281). I take this assertion by Rawlings, to mean that action towards rule following is a matter of contextualised judgement. The contextual judgement of nurses being that in order to enter the ICU they have to comply with the boundary rule to wash their hands. The hand-wash dispenser, to use Callon's description has become an 'obligatory passage point', where compliance to the ordering of movement is necessary to crossing the threshold between the ICU and the wider hospital environment. However, in following the requirements, the nurses' performative action only adheres to the symbolic notion of infection control. The action has become habituated into nursing routine on the ICU; it is something that nurses' bodies are made to do by the technology of hygiene.

However, there is a further dimension to these infection control efforts. Not bringing cotangents into the ICU suggest a certain moral compulsion upon nurses' practice (Brown et al., 2008). After all, ensuring the safety and wellbeing of others has a social moral component- cleanliness is next to godliness. In terms of cross infection, the NHS has seen a rise in hospital based infections (for example MRSA- methicillin-resistant *Staphylococcus aureus*); tackling the problem through introducing protocols for hand washing regimes (Pittet, 2001). However, Pittet's study discovered that health workers are pretty poor at hand washing, indicating that alcohol-based hand rubs are more effective in the management of cross infection. The point I want to make here links with Latour (2000) that the moral action imbued in infection control has now been prescribed onto technology. The outcome or effect of this network of infection control is that ICU must comply with hand rubbing every time they enter the unit. The technology enforces the mortality back on the nurses, by controlling their embodied symbolic action through the boundary space between the ICU unit and the wider hospital. Meaningful symbolic actions performed by nurses in interaction with ICU equipment will become a significant feature of the interview findings presented later in the study. That is to say, knowledge is constructed as a springboard for meaningful activities by nurses in the context of technological devices. I have thus far offered a description of the hospital and a detailed description of the ICU.

Within the ICU domain I have presented a number of object ethnographies, where I described the main features of the major technology used in the ICU. I have attempted to show how these technologies are taken up by nurses. I also concentrated on the boundary spaces of the ICU, suggesting that they are imbued with symbolic properties that use intervening technology (hand cleansing) to reinforce medical boundaries. I also hinted that as well as ICU staff principally ordering and negotiating the technological environment of the ICU, the actually technology has a part to play in the social and moral ordering of the ICU. In the next section I will take a closer analysis at how technology in the ICU might be seen to further determine the conditions of nurses' practice.

5.0 DISCUSSION

In the review of the literature, I presented some theories of technological understanding. I wrote about determinism as an explanation of technology, but concluded that determinism presented too reductive an approach to the place of technology in society. By contrast, a social shaping perspective on technology considered that devices, machines and indeed innovations come about, and are shaped through social actors either working in consort, as in relative interest groups sharing the same concerns regarding the development of particular technological objects, or groups and individuals in conflict over certain technological developments (Akrich, 1992). The constructionist or social shaping model of technological development insists that new technology has to be understood within the wider

context of social, economic, and moral worlds. This particular cluster of theories insists that no technology arrives on the scene as some finished object ready to influence social interaction. Instead, technology is shifted, shaped, and made compliant to the social context of its application.

I presented the findings in four chapters. In each chapter, I wanted to cluster the findings around themes that developed from the analysis. Chapter 5 explored dependency and suggested that nurses' actions were to some extent determined by the technology. Chapter 6 explored how nurses might shape the technology for social purposes beyond the given designed use of the technology. In chapter 7 I presented evidence that indicated how nurses, in mediation with technology, formed representations of patients.

While this structure might have suggested recourse to the determinist/essentialist dichotomy outlined by Timmermans and Berg (2003), my purpose in using this vocabulary was to explore how ANT may explain particular nursing interactions around technology which exhibit qualities of both determinism and social constructivism. ANT would not deny that actants could be at one moment determined by technology; however, this is not absolute. At one moment, nurses appeared to be calling the shots, building heterogeneous elements together to promote a particular outcome. A moment later, technology as an obligatory point of passage (Callon, 1986b) required nurses to perform and interact at the behest of the machine. Here, it might be said that the machine is the heterogeneous engineer, consolidating disparate objects such as patients, blood tests, and nursing protocols. The thrust of my argument was that networks produce effects that seem to reflect classic modalities of talking about technology.

Similarly, when ANT talks about 'intermediaries' and 'mediators' (Latour, 2005, p.37-46), there is both a discernable deterministic and shaping quality, respectively, placed upon actants' action. Whereas *mediators* shape the configuration of the network and the objects therein; *intermediaries*, in Latour's words, "…are *made* to act by many other" (2005, p.46, Latour's italics), therefore, having a determined quality to them. The difficulty is in knowing what the actant's role is in the network at any given moment. ANT revealed the dynamic nature of nurses' understanding and interaction with technology in the empirical world of the ICU, though when dealing with the world through the lens of ANT; when ANT recommends that the researcher 'follow the actors', one has to be prepared to shift sociological certainties (Latour, 1987, 2005). Invariably, nurses' accounts (as with all actors) present a discursive tangle of actions of reciprocity, values, empowerment, and submissions and so on. In the discussion that follows, I will demonstrate how ANT has explained how nurses interact with the technology within the context of the ICU.

5.1 Nurses as dependent actants in networks

In chapter 5 I explored how nurses, as an effect of the network configuration, come to be dependent on the technology they work with in their care practices. The reason for this lies with the critical nature of the illness presented to ICU staff. Illness, injury, and disease that require medical interventions at the micro physiological level also rely on the input of sophisticated technology that can observe and report on the progress of illness. Because nurses become dependent on the technology to perform effective treatment regimes, nurses enter into network arrangements where the devices present as obligatory points of passage (Callon, 1986b). It is not that nurses are enrolled into networks unwillingly, as I highlighted in the findings, there is something to be gained for nurses in terms of role status by taking on the complex tasks surrounding technologically imbued care. To achieve this, nurses become locked into the network where the task in hand is to 'look after organs', 'chase numbers' or 'balance patients'. As I indicated when reporting the findings, these metaphors for nursing care are constituted by the functionality of the technology. The necessary dependency on the technology for nurses to provide critical care involves framing the patient's illness in line with the operational purpose of the technology. Where separate devices are designed to maintain each organ system (ventilators for lungs, dialysis machines for blood etc.), nurses' understanding of the patient's illness and the care processes involved is directed towards 'looking after organs'.

This thesis has demonstrated that ICU nurses have to work within the medical technology network if they are to care for patients. Moreover, whatever technology the patient's condition calls for, the device operates as an obligatory passage point. It claims the attention of the nurses, and shapes the conditions of interaction, even to the point where the patient is enrolled and configured in line with the technological discourse. Thus, nurses talked about chasing and balancing numbers as a stand-in for patient stability. Numbers are important in the ICU technology network; they are forms of text or inscriptions. Inscriptions work as rhetorical devices, carrying within them, in the context of the ICU, persuasive power to alter and direct care interventions. Their purpose is to carry the modalities of medical science and technology to other locations to act as social objects of persuasion. Thus, the results from a routine blood-gases analysis entered onto a paper chart not only engages nurses' interests in continued involvement in the network aim- i.e. patient recovery, but also supplies evidence to maintain the *interessement* of other specialists in the ICU environment. Interestingly, in this example of activity surrounding the blood analysis technology, the nurse maintains their enrolment in the network through their dependency on the results to initiate further treatment (which might include the operation of the dialysis machine). It is in her/his interest to comply with the results and carry out

subsequent treatment decisions. I suggest this is not only for the patient's sake, but also for the nurse to demonstrate that 'being a competent ICU nurse' requires performative interaction with an array of technological devices. The latter point directs attention to the fact that what an ICU nurse is- an issue of ontology- depends on nodes of action that bring together heterogeneous elements. John Law (1992) puts the argument for human and non-human constituency this way: *"Analytically, what counts as a person is an effect generated by a network of heterogeneous, interacting, materials. This is much the same argument as the one that I have already made about both scientific knowledge and the social world as a whole. But converted into a claim about humans it says that people are who they are because they are a patterned network of heterogeneous materials."* (p.383)

I would further add that ICU nurses' understanding of their professional status and nursing identity is intrinsically linked to their network activities around technology. It is also pivotal to who they are as 'individuals'. This is to say, they have a psycho-social interest in maintaining 'subjectivity'. I feel this is the same point made by May and Fleming (1997) in that they raise the valid assertion that the content of nurses' empirical practice assigns their identity. However, I would further agree with Miettinen (1999), who insists that the "world of artefacts is a precondition for human subjectivity" (p.190). This point is just as true for the subjective experience of nursing identity in the technological environment of the ICU. It might appear that when talking about nurses' dependency on technology, the machines have ascendancy, enrolling nurses towards specific channels of interaction framed by the exigencies of the medical devices. In the example of blood-gases analysis, the outputs inscription from the machine directs nurses' actions towards further technological involvement in the network. However, demonstrating the dynamism in network configurations, nurses may also operate as heterogeneous engineers, using these inscription devices to enrol further actants, including other medical devices and professionals, onto the network. In their efforts to secure recovery for patients, nurses deploy blood analysis results as text evidence to translate the interests and concerns of medical specialists- and their technologies- to get involved in the patient's case. The point I am trying to make here is that ANT helps untangle the network pathways; letting the researcher explore contingent alliances and the types of objects/subjects they produce e.g. the dependent nurse, the determining machine. By tracing the actions and intentions of actants, human and non-human, analysis can ascertain the flow of influence at specific moments in the network, and the contingent worlds they make.

On the contrary, if analysis remains chained to forms of technological determinism, the structural propensity towards determinist explanations would necessarily dismiss the analytical potential of viewing nurses, even within technologically pervasive circumstances, as network builders and shapers of socio-technical interaction. ANT leaves the unfolding scene of actant interaction open to indeterminacy and change, moment by moment. According to Singleton and Michael (1993), the indeterminacy and ambivalence of elements within networks should not be looked upon as an issue of analytical fuzzy-ness. On the contrary, indeterminacy is about actants taking up or being allocated roles within the network, which are at one moment intrinsic to the configuration of the network, and at the next marginal to the centre of action. Nurses' role in network associations is encapsulated in the ideas of centrality and marginality. Take the next two quotes from the findings as examples. In the first, the nurse's account describes their dependency on the technology as a way to understand the patient's condition. The nurse waits for information to determine her actions towards caring for the patient. At this node in the technology-patient-nurse network, the monitoring device effectively determines the input of other actants - namely nurses. The nurse, for her part, remains marginal to the technology-patient interaction, only responding, as her account indicates, when the technology delivers information on the course of care. *Fn01, female nurse: "What information you've got from it [monitor] will determine how you're going to look actually, not from a clinical medical point of view but from a nursing point of view, how you are going to care for that patient."*

In the extract, the nurse appears to position herself in a line of command where she perceived her nursing role as being able to respond adequately to the signs from the medical technology. This role position could be taken as identity-in-practice work, where the individual sees ICU nursing as the ability to respond to the technology. On the other hand, it could be viewed as the technology translating the nurse, ensuring that the nurse understands her requirements as an effective ICU nurse, able to handle and respond to the monitoring outputs. There is a feeling of ambivalence in this arrangement, where technological dependency also offers nurses a form of identity management, *"from a nursing point of view"*. Fundamentally, ANT allows the researcher to think in these terms, that technological objects have agency to shape the understanding that nurses bring to their identity. If the marginality of nurses suggests a position outside the core action of network associations, then the notion of centrality puts the nurse-actant at the centre of network building strategies. The second quote below illustrates how nurses were able to take control of the construction of alliances, which were shaped by them to achieve the best possible care for their patients. *Fn09 female nurse: "I think we are quite autonomous in our practice for that one patient for a 12-hour shift or a seven-hour shift or whatever we are working. And we can initiate therapies, obviously working with the doctors; they are very receptive*

to our ideas. If we think something needs doing, they'll agree 'let's go ahead with it'. We're advocates of the patient as well."

In this quote, ICU nursing was now at the centre of action. The language use was authoritative, and indicates the kind of network building that had been accomplished in order for the nurse to practice with autonomy. For example, the statement that doctors *"are very receptive to our ideas"* suggested that the nurse assumes a stabilised set of responses from the doctor. If doctors are also the effect of network stability, then the nurse not only relies on the stabilisation on the doctor-network, but also works to maintain it. This might be through, as the nurse indicates, further network strategies such as black boxing 'patient advocacy' as a role particular to nurses. The authoritative assertion inherent in the discourse around patient advocacy is enough to stabilise the nurse - doctor interaction, leaving nurses to practice their autonomy over initiating patient therapies, invariably involving medical devices. In terms of the nurse's account above, there is a marked difference in the command chain from the previous quote [Fn01], now it runs- nurse → doctor → initiated technologically derived therapy. To achieve this, the nurse has had to work at securing alliances, persuading doctors to acquiesce to the fact that through her long bedside vigil, which is another manoeuvre for network ascendancy, the nurse knows best for the patient. Constructing the nurse in this way, as central to network build efforts, throws up issues that need further explaining.

Firstly, are nurses, as autonomous agents, free to cluster other heterogeneous elements towards their own empire building goals? Secondly, what does this say about how nurses achieve an identity as ICU nurses? These questions, in fact, are interconnected. ANT addresses these issues by saying that although it may look like some actors present themselves as autonomous tacticians, with the wit and nerve to draw together and command the services of other elements in their networking aims, the truth of the matter is these same actors are dependent on the existing enrolment and stabilisation of surrounding elements to enable the power to build. Thus the concept of power in ANT is associated with forces of alliances within the network and not with individual actants (Law, 1999; Latour, 1996). In the same way, nursing identity building should not be looked upon as established through some internal subjective voluntarism. On the contrary, identity formation is similarly dependent on the inter-relationality of actant elements circulating in networks.

Therefore, in both quotes above, there are two forms of nursing identity defined in interaction with the technology. The first [fn01] sees ICU nursing as being able to respond and make sense of technological monitoring, converting machine knowledge into care interventions. The second nurse's [Fn09] identity is configured as an autonomous agent able to act independently of the medical staff when instigating therapies for patients. In each case however, nurses' understanding of who they are as nurses only appears in the world as the effect of relationality to other actant elements. This suggests that identities, rather than being fixed, are in fact mutable in relation to the other shifting elements operating within the network.

The last point returns me to the findings presented in chapter 5. In this discussion it might be appropriate to reconsider the technological dependency of nurses as in fact a relationality of co-dependency between nurses and all actants in the network. Thus, a technological problem, e.g. a clotted line during patient dialysis, becomes a nursing problem translated into a setback in the patient's recovery. Similarly, when confronted with the problem of patient dialysis nurses are compelled to comply with the requirements of blood filtration technology, including maintaining its functionality. In this respect, the machine, like many of the sophisticated medical technologies in the ICU, commands nurses' attention as an obligatory point of passage in the patient's treatment. However, this scenario, on closer inspection indicates a co-dependency between nurses and the technology they interact with. On the one hand the nurse requires the technology for patient care, and is thus obligated to perform their nursing tasks through it. On the other hand, the machine requires the co-opting of nurses, along with a host of other network components, technicians, consultants, tubes, patient blood, in order to carry on as a viable technology. Crucially, these states of network alliances are indeterminate and precarious, liable to be reconfigured at other points and in other contexts within the ICU networks.

In the same way, nurses' understanding of the situation is partial. From the perspective of any one of the actors involved in this interaction, the role of the nurse could look quite different (Singleton & Michael, 1993). However, this is what emerges in analysis when one follows the actors. It is the partial perspectives of all the heterogeneous elements that result in indeterminacy in networks and indeed leads to failure when attempting to secure analytical closure. The researcher could trace all the actants in the network to resolve the matter, however this would be a formidable task due to the rhizomatic form networks take; ever expanding into new territories of actant engagement (Dolwick, 2009). By following other actors, we find that at different temporal nodes in the network, others are trying to re-open black boxes and resist enrolment, which are all factors that lead to occasional network instability. A case in point from the findings in chapter 6 was when nurses disclosed that in their efforts to work with certain technology; doctors will undo efforts by asserting that particular devices were "random number generators." *Fn11, female nurse:" Quite a lot of our consultants have lost faith in the information the machine gives them. We're*

actually using different machines now… So we very rarely use these machines anymore, because we've lost trust in the information they give us."

Consultants happen to be important components in the ICU network. Therefore, their disengagement signals a sizeable rupture in the efforts to stabilise routine use of the technology in cardiac care interventions. The LIDCO heart monitor, as a once stable technology used by ICU staff, has become untrustworthy. This fall from grace for this particular device has come about through subsequent innovations in cardiac monitoring. The interesting thing about the LIDCO's history is that, according to interviewed nurses, as a technology it has always been untrustworthy. The nurses who were interviewed report that setting it up involves a series of invasive convolutions. When operating, it required regular re-calibration, and for all the effort on the part of ICU staff, it returned dubious monitoring results. Nonetheless, back in the day when its innovative features were viewed as the best in cardiac monitoring, it was able to draw together heterogeneous elements within the ICU towards ensuring it functionality. New devices and techniques in cardiac monitoring have caused the LIDCO black-box to be opened. The result is that alliances which held it together have now become unstable. However, the LIDCO remains the monitoring tool of choice in particular care scenarios, where some consultants favour it while others refute its merits. In science and technology studies this situation is the stuff of technological controversy (Collins & Pinch, 1998; Pickering, 1992).

ANT enables us to understand this situation as the inherent instability of actant enrolment. Indeed, characterising the LIDCO monitor as a 'random number generator' is now an effect (or outcome) of the precarious network built around the device. In addition, if we consider the LIDCO in terms of its immutability- its ability to remain constant in form and purpose across the network- then its shifting inscription from cardiac monitor to *random number generator* suggest that time and innovation has very much made this technology mutable. It has, semiotically speaking, changed shape, and taken on a new identity through its technological lifetime in the ICU.

But where does this leave nurses' understanding of the device, with regard to their identity-in-practice? Interestingly, the nurses somehow stand between intersections of network influence. On the one hand they are led to operate the monitor by particular consultants, while on the other hand other senior staff refute the usefulness of the machine. This results in nurses demonstrating ambivalence to their identity (as a network effect) in relation to their practice with this particular technology. As the quote above indicates, the nurse shares the reluctance of consultants to rely on the machine. It might be considered that this stance marks their refusal to remain enrolled in this particular machine network. If the alliances that surround the LIDCO have broken, it is due, I suggest, in some way, to nurses working to protect their role and standing as technologically astute actors: "*we very rarely use these machines anymore, because we've lost trust in the information they give us".* There are new alliances to be made with other devices. The problems of the old machines are now not the nurse's problem. Their interests lie with the capabilities of other technology to support their patient's care.

5.2 Nurses' Social use of Technology

I explored how nurses might use technologies in their interaction with other actors in the ICU environment. Here I was interested in the social affordances of medical technology beyond their actual technological function in the care of patients. For example, although nurses employ an array of monitoring devices to gather physiological information, the findings indicated nurses also used the technological information to mediate their status in relation to senior medical ICU staff. In addition, when nurses dealt with the death of patients, they again 'shaped' the semiotic qualities of technology in relation to patients relatives' expectations of bearing witness to the moment of death.

According to Law (2009), ANT recognises that technological objects can own layers of meaning which are open to appropriation by 'human' actants in their network building strategies. This is to say, the sign system in which nurses (and other ICU personnel) take their understanding from is one that is *necessarily* shared by all participants in the intensive care environment. I use the term *necessarily* to indicate that the world of ICU exists as a totality of meaningful practices, where the community participates in the collective circulation of meaning. Referring to this manifold of meaning, Suther (2006) describes it as the production of "intersubjective epistemologies" (p.318). Accordingly, meaning is created jointly in the interactions of group actors, but also actors can 'use' the shared meaning to mediate forms of interaction. Thus, the material 'reality' of the ICU is informed by the meaning-making practices of all who share the network environment. The technologies of the ICU are part of the semiotic or symbolic field in which nurses, consultants, patients and their relatives participate. As John Law (2009) states: *"We've seen that material-semiotics explores the enactment of realities, the ontological. We've also seen that it describes the making of knowledge, the epistemological."* (p.154). Put another way, nurses are able to shape the symbolic meanings of technology to effect particular social interactions. When I presented the social affordances (Hutchby, 2001) that ICU technology offered, I was directing attention to the semiological qualities inherent in machines. In other words the machinery becomes a form of text or sign to be read. I would argue that nurses work to shape the technology as text to produce social effects. As Hutchby (2001) emphasises, "users … may seek to produce readings of the technology-

text that best suit the purposes they have in mind for the artefact" (p.445). So in the findings when the nurse talked about removing the technology from the dying patient, I indicated that the nurse was in effect mobilising a textual 'reading'. Wherein the removal of the technology signified to the patient's loved ones that the passage to death was perhaps imminent, and that they should bear witness to the actuality of the dying patient and not to any signs of death displayed in the technology. These insights from nurses' social practices surrounding death in the ICU have resonance with Timmermans' exploration of death in the emergency department (Timmermans, 1998). Timmermans also records that far from technological involvement effectively dehumanizing the social aspect of death (Moller, 1990), in enacted resuscitation efforts, technological devices can mediate the transition of death, by affording space for relatives to come to terms with the death of the patient.

As the previous extract from the findings demonstrates, machines in the ICU environment are used not wholly in terms of their technological affordances. That is to say, social affordances move the uses of technological devices beyond the direct purpose built into them as part of their designated technological role. Those who design and manufacture technology work to secure a particular use of the technology: how it should be operated, who should operate it, and in what context. It is not that ICU nurses use technology incorrectly, but they might employ it to achieve other ends, which creatively extend the textual qualities of devices. In doing this, nurses open up a space, which engages the technology in the social contingencies of the world. Of course the idea of social affordances does not suggest that anything goes in terms of using the social element of technology, the logic of local practices in which the technology is placed in some way defines the limits of the social affordances of the technology (Hutchby, 2001). I am seeking, with this example to bring attention to how nurses as heterogeneous engineers are able to enrol machines into alliances in order to shape interactions with human and non-human actants. In some respects, the activities involved in network building amount to persuading and enrolling other actants on to networks. I reported in the findings that this is most notably achieved when nurses situate themselves as an obligatory point of passage, ensuring that other actants, namely doctors, have to engage with nurses to understand the patients' condition. *Mn03 Male nurse: "I'm not saying that I know better than the doctors, but I do think because I'm spending more time with the patient I am the best person to relay changes in their status condition… because I monitor them closely*."

The power/knowledge relationship, enacted through technology, gives nurses a level of status enhancement in the ICU. Thus, in the findings in chapter 6 where I discussed nurse-doctor interaction, nurses were able to challenge the treatment decisions of doctors, through their intimate knowledge of the patient's condition, provided through intensive monitoring. Once more, I would argue, nurses are appropriating the textual quality of machines beyond their technological affordances. This is to say, they use their position as knowledge providers in terms of the patient's condition, to mediate their social-professional status in relation to medical staff. For their part, doctors, consultants, and surgeons, as participants in the epistemological community, 'recognise' and indeed acquiescence the symbolic knowledge/power held by nurses, through their tacit acknowledgement of nurses' expertise. This interaction, as well as operating through the materiality of the ICU technology, also operates at the semiotic level, where signs, symbols, and texts flow in the circuit of meaning that makes up the ICU world. This analysis is similar to Carmel's (2006a) examination of the doctor-nurse relations in his study of the ICU. I agree with Carmel on the notion of a shared project of the ICU. However, my analysis suggests that nurses' use of technology-in-practice reveals, as with other examples presented in the findings, that the doctor-nurse relationship is mediated around the social, symbolic and crucially the material qualities of ICU technology. For example, ownership of the knowledge and information that the technology provides very much structures the status relationship of the two professions.

All this raises an interesting point in ANT analysis. The point I have been making throughout this thesis is that ANT usually assigns outcomes or effects to stable networks. Thus, it might be considered that an ICU nurse or a LIDCO machine materialises as an effect of a stabilised network of heterogeneous elements: designers, manufacturers, trainers, codes of conduct, technicians, power supplies etc. But what happen to the nurse as a network effect when a particular network untangles, when elements remove their enrolment or the dimensions of alliances shift? The answer is that nurses don't disappear. Instead, I would argue that the breakdown of networks produces further effects at other points in the web of association. Indeed, the suspension of particular network alliances instigates actants to reassemble elements, find new associations, and begin the work of stabilising new networks. So, the nurse's suggestion that the old filtration machines are "dying" can be taken as an effect of the destabilised network of elements that once surrounded it. Having observed the efforts involved in introducing the new technology to nursing practice, I can testify to the trials that nurses undergo in assimilating new forms of knowledge and expertise in to their practice. For a while, the network elements- amongst which are company representatives, training sessions, product manuals, and nursing protocols- will remain visible. However, in time, nurses will shape their understanding of the technology, and socialise the technology as an extension of their nursing practice and identity; whilst the stabilised heterogeneous elements will vanish into the background. The network, according to Law (1992): *"[W]ill be replaced by the action itself and the*

seemingly simple author of that action. At the same time, the way in which the effect is generated is also effaced: So… that something much simpler… comes, for a time, to mask the networks that produce it." (p.5)

The simplicity that is arrived at in the normalising of nursing practice around technology, frames the technology as a neutral component in their endeavours to care for patients. Although nurses are involved in the minutia of network activities, the complexities of the network arrangements are never wholly disclosed to them, through their actions. Furthermore, nurses in their everyday work do not recognise their network building strategies, or in fact, that they may be influenced by heterogeneous engineering strategies of a host of other actants, including technologies, pushing them this way and that way, enrolling them through unspoken interests. The findings disclose that nurses do operate strategically, using their own power and influence to configure representations of patients. When looking through the lens of ANT, the network world of the ICU and nurses' understanding of it comes to the fore. Networks can be traced, to some degree, to enlighten nursing practice around technology in the ICU. Within Chapter 2 I examined various sources of science and technology and nursing literature, and agreed with May and Fleming (1997), and Carmel's (2013) argument that standard nursing theory may not serve its purpose. What nurses should do by way of prescribed theories of practice does not capture fully the boundary of ICU nursing in context. Where I differ with Carmel is in the mode of analysis of these fundamental socio-technical relations. My focus, although it touches upon many of the themes raised by Carmel, has been to find explanation for the changing practices of ICU nurses in the complexity of socio-technical arrangements. Carmel appears not to consider the radical consequences of technology upon nurses' social interactions with other actors in the ICU. Although he recognises the materiality of technology in the ICU, he eschews the nonhuman charisma (Lorimer, 2007) of technology to hold the same ontological forces as human actors (Carmel, 2003).

I, on the other hand, understand the force of technology in the ICU to mediate care interventions along with nurses. The ICU is a complex world; and to explore how nurses understand it, requires unravelling the complexity that involves both technological and social interaction. Not all nursing interactions around caring for patients on the ICU are technological, although they may appear as such on the surface. Likewise, analysis of supposed direct social (and political, economic) exchanges must admit the importance of technology as a mediator in those interactions. Returning to Timmermans and Berg's (2003) analysis of technology-in-practice, I have demonstrated the complexity of technological involvement in the ICU, and demonstrated that nurses understanding and use of technology configures a great deal of the practice that goes on within the ICU. Moreover, nurses, in their interaction with the ICU technology nurses, are able to articulate the symbolic qualities of the technology. Through this articulation nurses subtly reconfigure both their own and patient identities. Theses identities are not static, but dynamic and mobile. Hence, I showed in the findings in chapter 7 that patients' identities are transfigured in socio-technical networks, as they move through the ICU care regime. They move from 'technological bodies' to 'social bodies' as an effect of the changing representations of patients constructed by nurses. This transfiguration comes about as a necessary component of both nurses and patients' reliance on network alliances with the life-saving technology; making it possible for the former to practice and the latter to survive.

5.3 Future Research Using Technology-in-Practice

Timmermans and Berg (2003) ask that future research of technology and medicine is alive to the creative interplay of actors and technology and the social context of interaction. In the last decade or so, the technology-in-practice model has informed the diffusion of technology in healthcare environments (Ulucanlar et al., 2013; Peiris et al., 2011; Harrison et al., 2007; Poland et al., 2005). These studies have looked at how technology has been adopted across a range of healthcare settings, ranging from hospitals to GP practices. At the same time, the UK health service, through the institutions of Health Technology Assessment and NICE (National Institute for Health and Clinical Excellence), has attempted, through protocol and guideline processes, to ensure the stable transition of new innovations into health practice. However, the guidelines given for diffusion have often been criticised for using the assumptions inherent in probabilistic science, and efforts towards the routinisation of practice around new technologies (Chalkidou et al., 2007). The message from technology-in-practice has been that technological adoption must be understood as presenting a complex interplay of social processes; technology innovation does not simply transfer from design to manufacture to practice in a straightforward linear progression.

In a recent study undertaken by Ulucanlar et al.,(2013) the authors set out to inform the introduction of technology by placing diffusion efforts within the empirical world where the social context informs the adoption of technology. The important message from this work is that to understand the successful adoption of new technologies, the researcher must undertake a sociological analysis of how technology is taken up taken in the world of health care. Ulucanlar et al., concurring with my theoretical perspective, use ANT as a lens to provide a framework which includes investigating the social identity of both technology and humans as a valuable indicator into technological adoption by healthcare organisations. Ulucanlar et al., (2013) have identified that the: *"Adoption processes are strongly socially*

mediated by technology identities: a set of composite and contestable attributes that give each technology a distinctive, if contingent, character. Identities reflect actors' social orientation and the cognitive necessity to define and imbue with meaning other actors, including… the nature of the technology itself and its material properties." (p. 103)

In conclusion, I recommend that research and policy guidelines reflect the complex and contingent nature of socio-technical network arrangements. Any prior assumption about how technology will interact with individuals and organisations should be laid aside. Emphasis in policy guidelines should be on understanding the co-configuration of human and technological identities. Ulucanlar et al., (2013) have developed a useful framework which articulates the uptake of machines beyond their technological usefulness, as devices that enable identities of use. However, what is not clearly understood in the findings presented by Ulucanlar et al. is the possibility of reciprocity of identity construction in the interactions between professionals and machines. In my study, however, there is a thread throughout that alludes to the ideas that through their understanding of technology, nurses adopt and play out forms of identity in relation to socio-technical networks. In relation to my thesis, future research on ICU nursing and technology adoption might consider the possibility of socio-technical interactions to configure positive nursing identities as a strategy for technological adoption in the ICU.

5.4 Conclusion

This thesis set out to explore ICU nurses' understanding of technology, and sought to answer the questions: In what way does nurses' understanding of technology in the ICU mediate their use of this technology? Do technology and technological regimes shape nurses' ideas and representations of patients, and the forms of care they provide? In order to investigate these questions I used an ethnographic approach, informed by ANT. Using this theoretical approach my aim was to investigate technology-in-practice, to pick up on the nuanced socio-technical interactions between nurses and technology. I found that by taking this approach I was able to gain a picture of how at one moment nurses' understanding of technology revealed their dependency on the technological arrangements in the ICU in order to care for patients; whilst at other points, nurses used the technology to mediate social interactions with others to achieve socially significant outcomes. However, when analysing these interaction moments it was important to understand that nurses' dependency upon, and social shaping of technology were a dynamic feature of the socio-technical interactions of a whole array of heterogeneous elements operating in the ICU network.

A further message from this study was that nurses' interactions with technology provided an opportunity for nurses to construct a number of metaphorical identities: as 'mini doctors', 'scientists', and 'technicians'. These identities, I argued, were an outcome effect of the socio-technical networks that make up the ICU. A technology-in-practice approach, such as ANT, with its interpretive flexibility allowed the dynamism of real world interactions to emerge from the data. I have argued that ANT provides an important means to make sense of the data, and have suggested future research using an ANT as a technology-in-practice perspective might focus on how nurses' identities in particular might be shaped by technology. Also, how in turn, nursing identities constructed in socio-technical network interactions, might inform the adoption of new technologies in the ICU.

In closing, I believe the findings presented in this thesis add to an understanding of the complexity of technology diffusion and implementation in nursing practice in the ICU. My sociological account casts light on some of the complex interplay between nurses and technology. Modestly, I hope that these insights can help to address the issues faced by nurses and by extension, patients, their relatives and designers of medical technology.

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